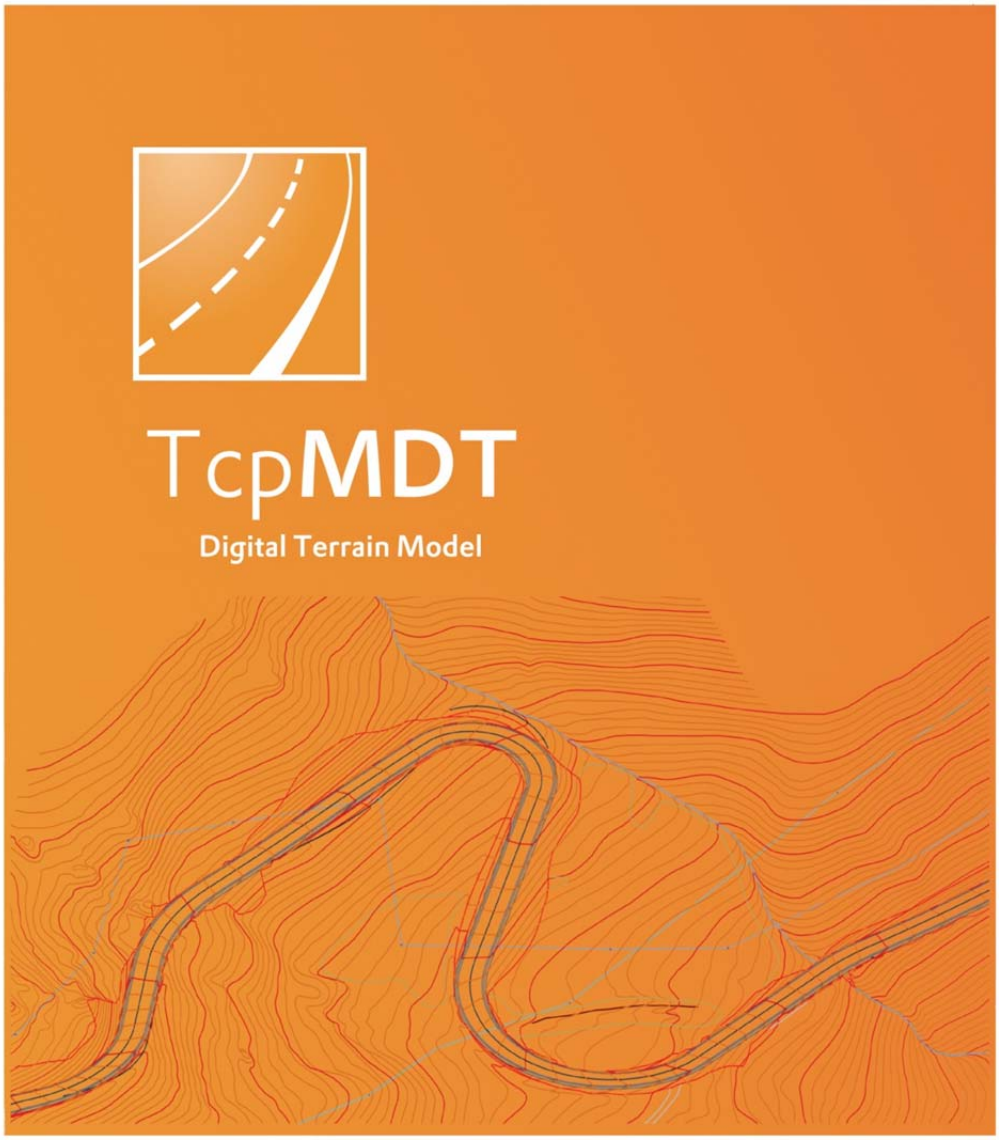
User Manual

Versión 6



aplitop
Surveying and
Civil Engineering Solutions

Summary

Introduction 3
Tutorial 1 Managing Points 5
- Program Start-Up 5
- Creating the Project 5
- Import Points 6
- Change Symbols 8
- Break Line Definition 8

Tutorial 2: Contour Lines and Profiles 11
- Creating the Surface 11
- Editing the Triangulation 12
- Quick Profile 13
- Generating Contour Lines 13
- Labeling Contour Lines 15
- Defining the Alignment 16
- Obtaining Cross-Sections 18
- Drawing Cross-Sections 19

Tutorial 3. Volume Calculation 21
- Computing Cross Sections 21
- Volume by Cross Sections Differences 22
- Volume by Mesh Difference 24
- File Summary 26

Tutorial 4. Road Design 27
- Project Selection 27
- Superelevation and Widening Generation 27
- Obtaining Cross-Section Profiles 30
- Vertical Alignment Definition 31
- Template Definition 32
- Drawing Profiles 36
- File Summary 37

Tutorial 5. Templates from Drawing 39
Tutorial 6. Obtaining Modified Terrain 43
- List of Cubic Measurements 44
- Volumes List 45
- Setting Out 46
- Video Generation 48

Tutorial 7. Explanade Creation 51
- Explanade Drawing 51
- Earthworks by Explanade Elevation 51
- Earthworks by Terrain Elevation 52
- Route Terrain Simulation 54

Tutorial 8. Alignments 55
- Element Fitting 55
- Element Connection 57
- Conversion to Alignment 59

Tutorial 9. Survey Calculations 61
- Data Collector File Conversion 61
- Coordinate Calculation 62
- Station and Point Drawing 65
- Traverses 66
- Other Calculation Procedures 68

Tutorial 10. Geodesic Calculations 71
- Import Points 71
- GPS Data Visualization 71
- Drawing Coordinate System Transformation 73

Introduction

The aim of this manual is to facilitate the learning process regarding the application with the step-by-step development of a project throughout its different stages. Complete information can be found in the **Reference Manual** on all the aspects not covered here in. It is assumed that AutoCAD is correctly installed and that the TCP-MDT installation instructions have been followed. For all samples we suppose that installation folder is *C:\Program Files\Aplitop\MDT6*, and projects folder is `C:\MDT6 Projects`. To the explanations be more understandable, a series of screenshots from the AutoCAD 2012 English version have been included. The other versions supported appear similar and their functionality is the same.

In order to showcase the program's capabilities with small projects and large projects ten different exercises have been included.

Standard Version

1. The first of these concerns a small survey of around 100 points on which some points management and line definition operations are performed.

2. In the second tutorial, triangulation, contouring, profile, etc. operations are executed.

3. The third exercise takes the data used in the first tutorial and performs volume calculations for both profile and grid difference methods.

Professional Version

4. This tutorial deals with a much larger project (around 750 points) in which almost all the functions are executed from previously prepared files. It is essentially aimed at designing vertical alignments, superelevations, additional widths, cross-section templates, etc.

5. The objective of this exercise, the same as above, is the construction of a road, but in this case the platforms will be defined from the drawing.

6. Modified terrain operations, obtaining volumes, setting out and realistic simulations are all performed in this exercise.

7. Subgrades are created and earthworks executed when the subgrade height or the contacts with the terrain are known, in addition to the drawing of solids and rendering.

8. An alignment is constructed using different road design elements (straights, curves and clothoids), to subsequently convert it into a horizontal alignment ready to be used with other commands.

Surveying Module

9. A tutorial is developed detailing how the topography module works, including the conversion of a file from an electronic data recorder, calculating its coordinates, adjusting a traverse and transforming UTM coordinates to geographic coordinates.

10. From a points file a datum transformation is made.

Tutorial 1 Managing Points

A construction company commissions a survey of a plot where earthworks are planned in a fill to be used as a parking lot that will later be landscaped in the northwestern area. Hence, the plan consists of subsequently filling this area with excess earth cleared from the plot.

Firstly, a survey is taken of the area possibly affected in its original state. A coordinates file is obtained as a result of the calculation process with any program capable of providing a coordinates file, which is imported with the relevant tool.

In order to generate a comparative cross-section plan containing the Administration's project, the Digital Terrain Model is executed with the aid of drawing objects (polylines) linking the surveying points and break lines. Made with MDT, the plot's cross-sections are then processed from the N-S longitudinal alignment having identical characteristics to those of the project at equal 2.00 meters distances from the aforementioned cuts to exhaustively compare them (by excess) with the project's original cuts at every 10.00 meters. This process will yield a cross-sections file.

Lastly, after taking another set of observations of the modified terrain, cuts are obtained from the modified terrain as well using the same alignment. Then the earthworks in both terrains will be calculated.

The process is described step by step throughout this manual's first tutorial.

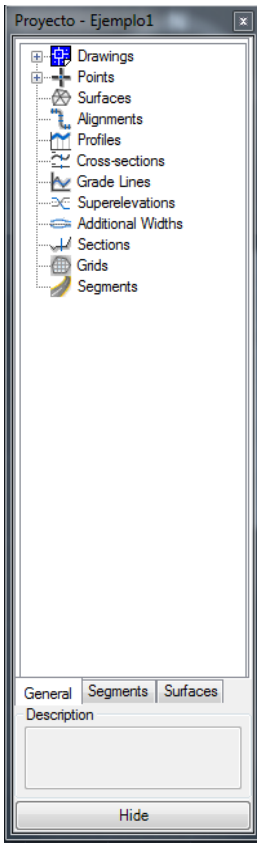
Program Start-Up

Click on the MDT V6 [CAD version] icon located on the Windows desktop or execute the MDT icon located in the Aplitop > MDT group created when installing the program.

Once it is executed, the CAD will run automatically and all the menus and toolbars will be enabled.

Creating the Project

By creating a project, better control is exercised over the files generated by MDT. When the **Project > New** menu is executed, the program requests a file name in order to create a new project. Enter the name `Tutorial1` in the `C:\MDT6 Projects\Tutorial01` directory. The project window shown below is then displayed.

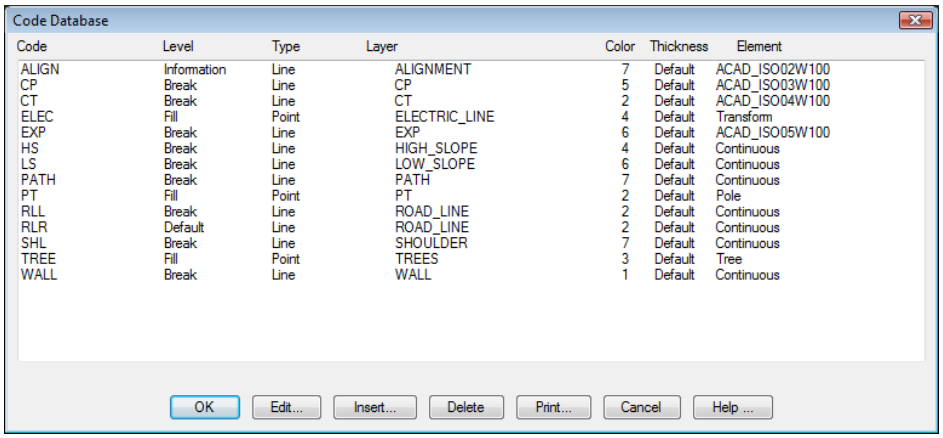


Import Points

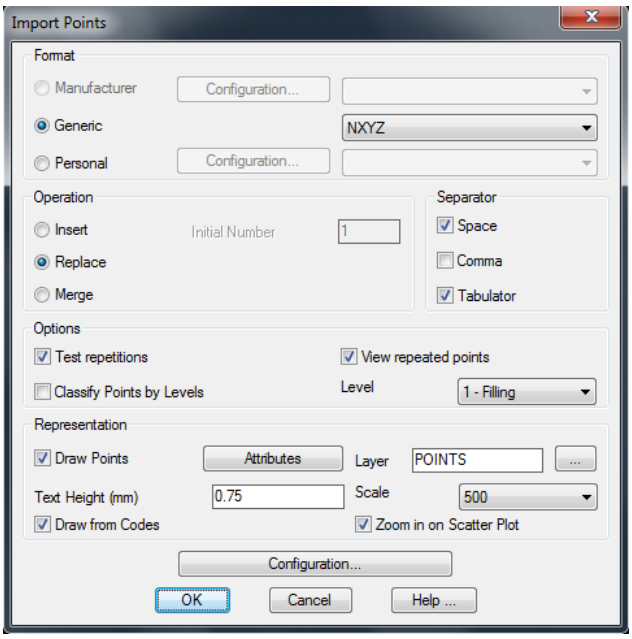
One starts off with a coordinate point file generated by any surveying program. The points can be entered manually or imported from a data collector. In this case, the file is called `Demo1.PUN` and contains 101 points. The table below is a fragment of the file, whose fields include: point number, X coordinate, Y coordinate, Z coordinate and code.

```
  2     257.836     264.781    46.570
  3     258.914     274.491    46.760
  5     260.736     284.925    47.130
  6     262.893     293.434    47.430
  8     265.817     301.429    47.560
  9     270.104     311.112    47.850
 10     272.797     315.505    48.180
 11     278.382     323.371    49.050
 12     282.897     331.671    49.700
 14     284.979     338.837    50.290
 15     285.349     346.624    50.910
 16     287.658     346.885    51.140 ALB I
 17     292.947     347.153    51.120 ALB
 18     296.339     347.070    51.120 ALB
 19     296.223     353.138    51.120 ALB
 20     284.724     373.268    52.160 CMI
 21     286.749     372.258    51.240 ALB I
 22     291.682     372.405    51.120 ALB
 23     295.453     368.948    51.120 ALB
 24     288.523     343.006    50.600 AES I
```

These points have been coded in the field, so that a graphic can automatically be generated reflecting part of the plan. The relationship between these codes and the objects to be drawn is determined by the codes database, which can be accessed and viewed using the **Points > Codes > Codes Database** command. Click on the **Cancel** button.

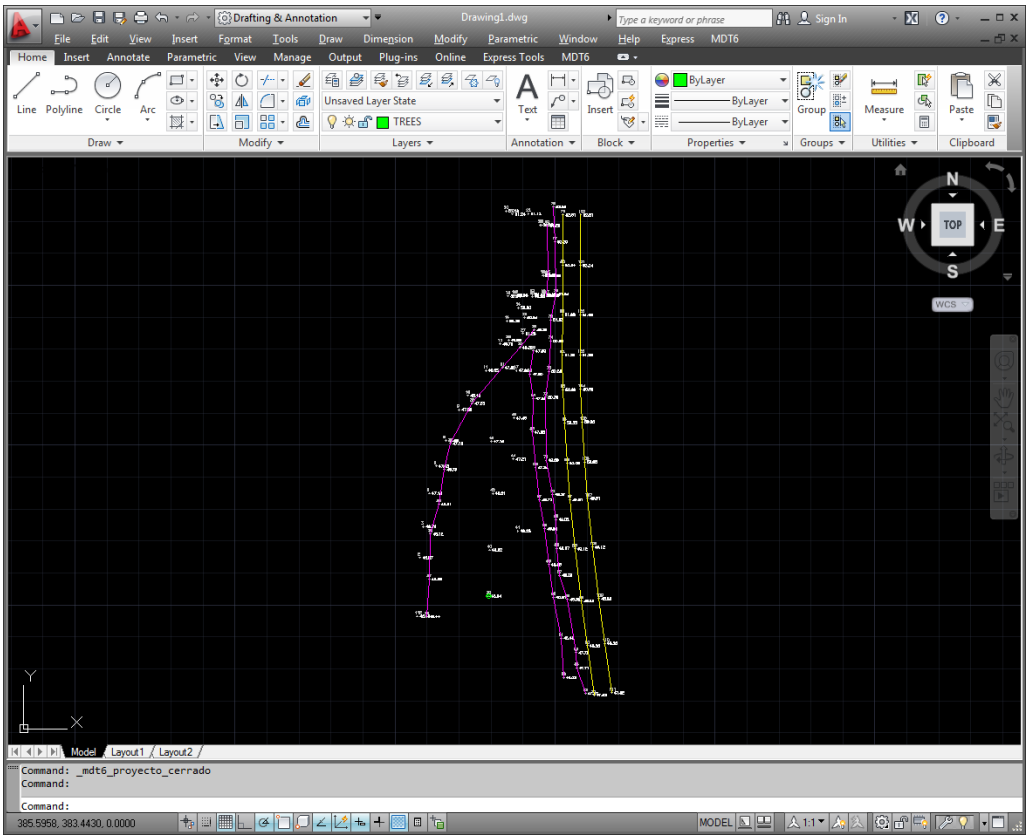

Code Database
Code Level Type Layer Color Thickness Element
ALIGN Information Line ALIGNMENT 7 Default ACAD_ISO02W100
CP Break Line CP 5 Default ACAD_ISO03W100
CT Break Line CT 2 Default ACAD_ISO04W100
ELEC Fill Point ELECTRIC_LINE 4 Default Transform
EXP Break Line EXP 6 Default ACAD_ISO05W100
HS Break Line HIGH_SLOPE 4 Default Continuous
LS Break Line LOW_SLOPE 6 Default Continuous
PATH Break Line PATH 7 Default Continuous
PT Fill Point PT 2 Default Pole
RLL Break Line ROAD_LINE 2 Default Continuous
RLR Default Line ROAD_LINE 2 Default Continuous
SHL Break Line SHOULDER 7 Default Continuous
TREE Fill Point TREES 3 Default Tree
WALL Break Line WALL 1 Default Continuous
OK
Edit...
Insert...
Delete
Print...
Cancel
Help ...

In order to import points, choose the **Points > Import** menu option. Select the ***NXYZ*** format within the ***Generic*** category, and set *Space* as the separator. Mark the ***Classify Points by Level*** and the ***Draw from Codes*** check boxes. Select a scale of **500**.

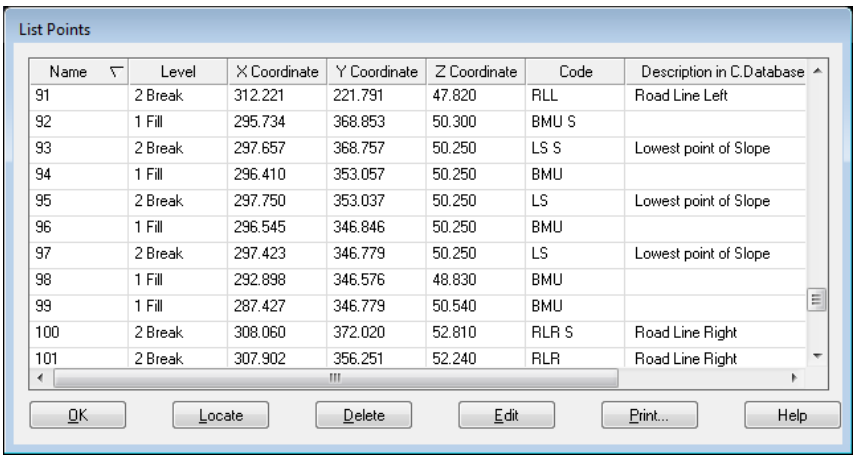


Click ***OK***. After validating the dialog box, choose the `Demo1.PUN` file in the `C:\MDT6 Projects\Tutorial1` folder.

The points defined in the file will be displayed on screen. Polylines and blocks corresponding to the point codes will also be drawn, according to the definition in the codes database. Check the layers that have automatically been created.



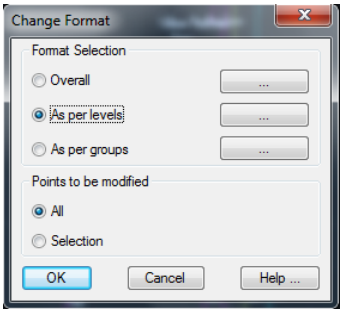
To check the imported data the **Points > List Points** command is used (or in ribbon **Points > Operations > List**). Using the dialogue box selection system, select ***All***. This shows the points' list containing their point numbers, levels, X coordinates, Y coordinates, Z coordinates and codes in the dialog box.


List Points
Name
Level
X Coordinate
Y Coordinate
Z Coordinate
Code
Description in C.Database
91 2 Break 312.221 221.791 47.820 RLL Road Line Left
92 1 Fill 295.734 368.853 50.300 BMU S
93 2 Break 297.657 368.757 50.250 LS S Lowest point of Slope
94 1 Fill 296.410 353.057 50.250 BMU
95 2 Break 297.750 353.037 50.250 LS Lowest point of Slope
96 1 Fill 296.545 346.846 50.250 BMU
97 2 Break 297.423 346.779 50.250 LS Lowest point of Slope
98 1 Fill 292.898 346.576 48.830 BMU
99 1 Fill 287.427 346.779 50.540 BMU
100 2 Break 308.060 372.020 52.810 RLR S Road Line Right
101 2 Break 307.902 356.251 52.240 RLR Road Line Right
OK
Locate
Delete
Edit
Print...
Help

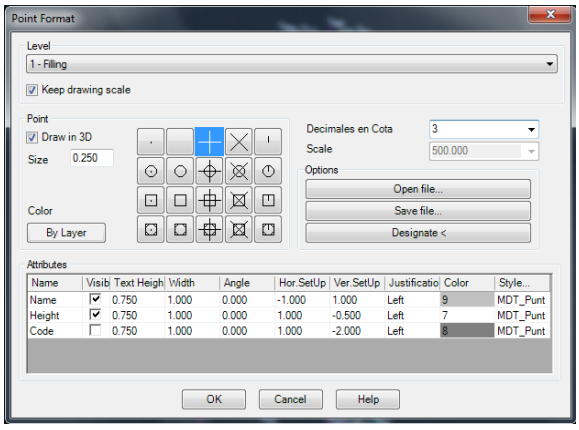
One can see that there are three point levels contained in the list: Information, Fill and Break Line

Change Symbols

A possibility offered by the program is to display each point in a different way depending on the level or group to which it belongs. Execute the **Points > Change > Change Format** command (or in ribbon **Points > Operations > Edit > Change > Change Format**). Select the ***As per Levels*** and ***All*** options in the dialog box.



Click on … and another dialog box is displayed that facilitates the configuration of the points' representation by levels.



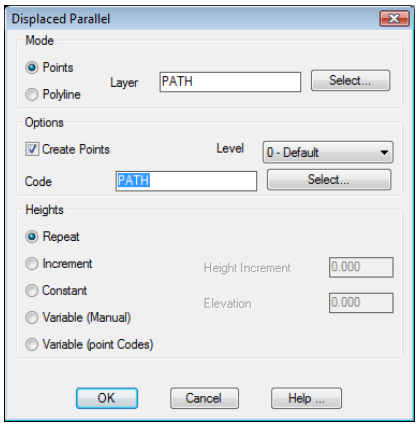
We change the number of decimals to 3 and activate **Draw in 3D** checkbox.

Break Line Definition

Due to the circumstances that occur in the field data gathering process, it is almost impossible to code all the points in an orderly way. It is therefore necessary to rely on other commands in the program to put together jobs.

Firstly, a path with a constant width will be drawn that only has one measured side. Amplify it using the zoom function in the project's lower left-hand corner.

Now select the **Break Lines > Displaced Parallel** command (or in ribbon **Break Lines > Creation > Displaced Parallel**). Select the ***Points*** mode. Enter the name PATH in ***Layer*** and activate the ***Create Points*** check box and also assign the ***Breaklines*** level and the code **PATH.** Lastly, in the ***Heights*** frame select the ***Repeat*** option and click on ***OK***.



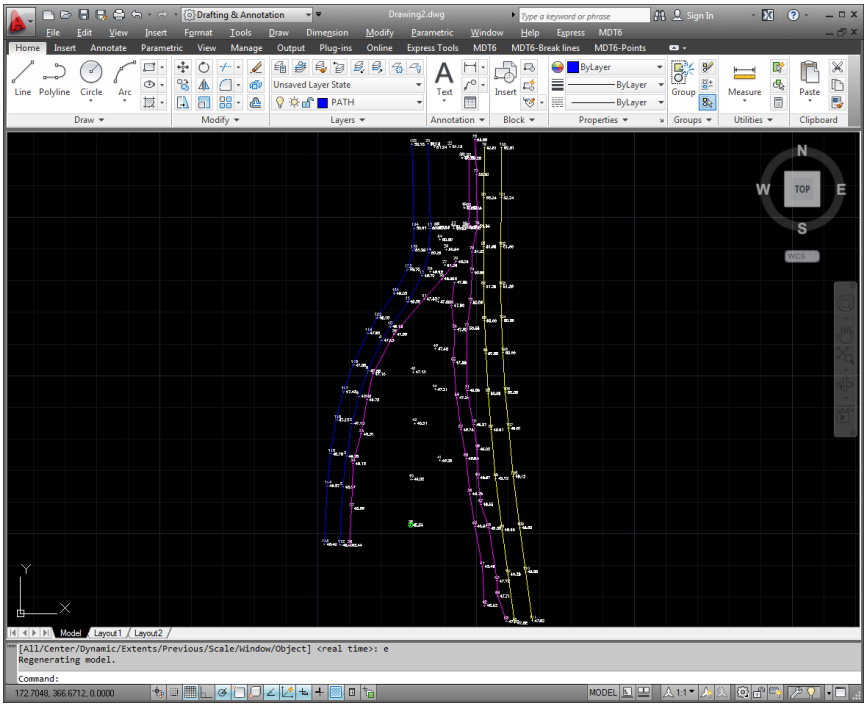
The following will appear in the command area:

```
First point:
```

Select locations near points 112, 2, 3, 5, 6, 8, 9, 10, 11, 12, 14, 15 and 20 in that order with the mouse. The transparent commands zoom, frame, etc. can help. If an error occurs, press ***R*** to discard the last vertex. After the last point, press *<Enter>*. When the program requests an orientation, click a point to the left of the newly created line using the mouse Continue to enter the data:

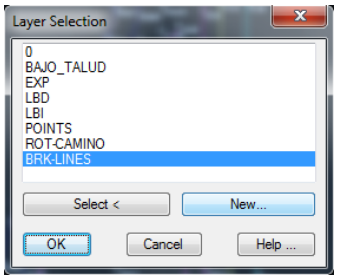
```
Separation: 5 <Enter>
13 points created
```

A new polyline can be seen in the PATH layer to the left of the original line and that each vertex has created a point having the same level as the corresponding original points.

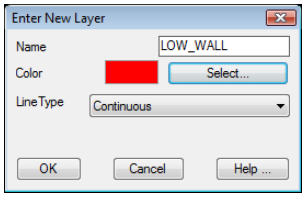


Perform another zoom extension. In the same way, one can manually complete the lines making up the lower part of the pond walls. Select **Break Lines > Point Numbers** (or in ribbon **Break Lines > Creation > Numbers)**.

Instead of selecting an existing layer, a new one will be created. Click on the **New** button.



Type in LOW_WALL as a layer name, click the ***Select*** button and choose red as the color. Click ***OK*** twice.



Enter the following point sequence:

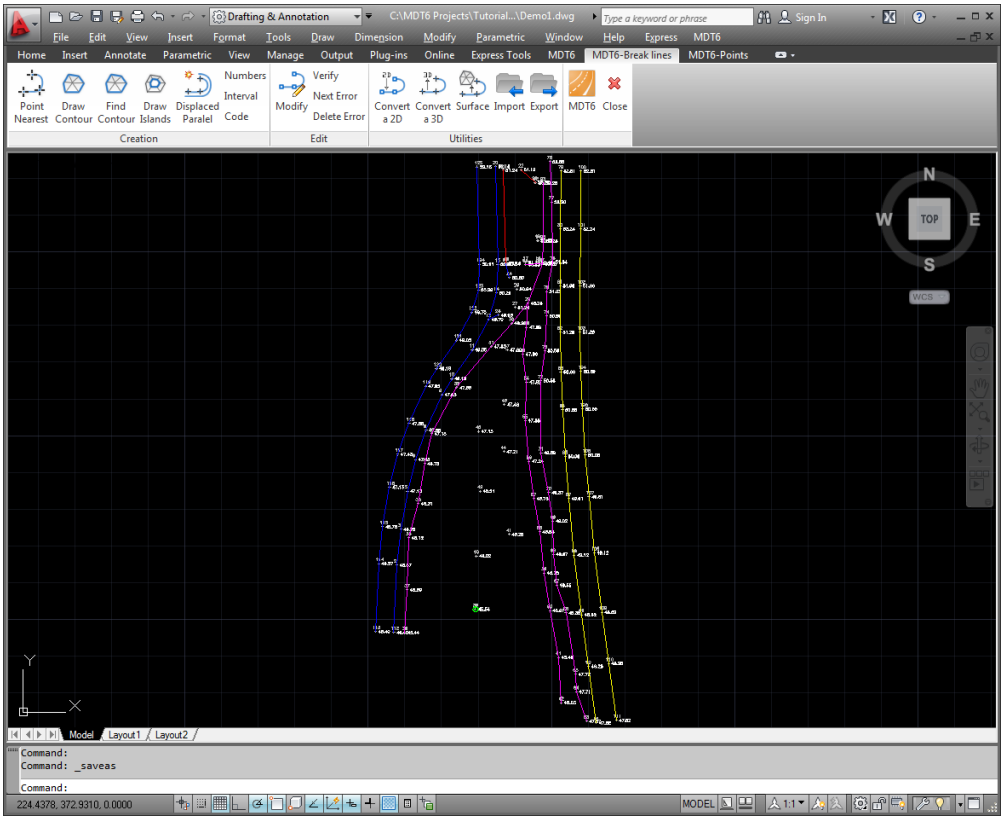
```
First point: 99 <Enter>
Other point: 21 <Enter>
Other point: <Enter>
First point: 92 <Enter>
Other point: 22 <Enter>
Other point: <Enter>
First point: <Enter>
Command:
```

Repeat the process to create the HIGH_WALL layer, using blue and the following point number sequence:

```
First point: 99 <Enter>
Other point: 24 <Enter>
Other point: <Enter>
First point: 28 <Enter>
Other point: 12 <Enter>
Other point: <Enter>
First point: <Enter>
Command:
```

Lastly, the lines of lower slope are drawn using the same command, but selecting the existing LOW_SLOPE layer. Join points 97,29,48 and then 97 and 98 using the aforementioned procedure.

The drawing configuration is complete. Save the drawing as `DEMO1.DWG` in the `C:\MDT6\Projects\Tutorial1` folder. As a project file is active, the program requests if one wishes to add the drawing to the project, which one has to answer yes.



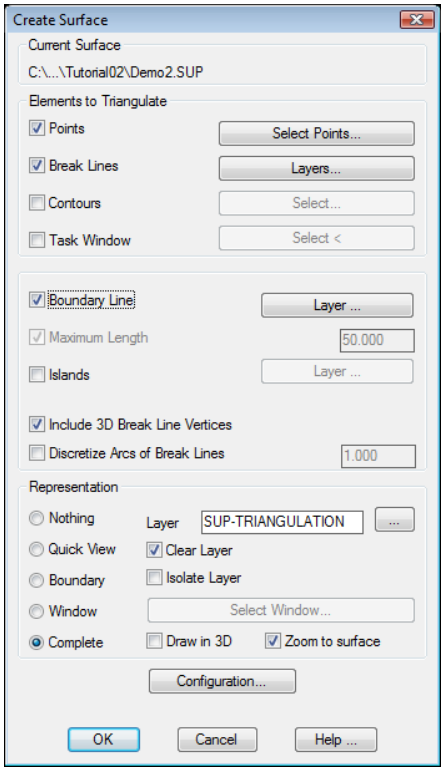
Tutorial 2: Contour Lines and Profiles

Each of the lines drawn in their respective layers make up the so-called break lines on their own, as they are directly linked to surveying points. At this point, the process of putting together the project has finalized, as the plan is defined. The Digital Terrain Model (DTM) will then be generated.

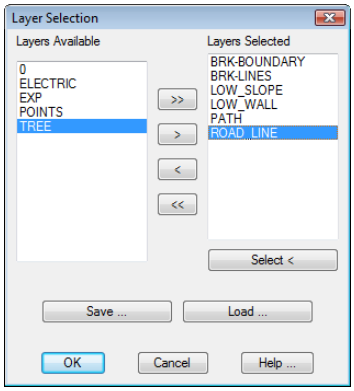
Open the drawing named `Demo2.dwg` located in the `C:\MDT6 Projects\Tutorial02` folder

Creating the Surface

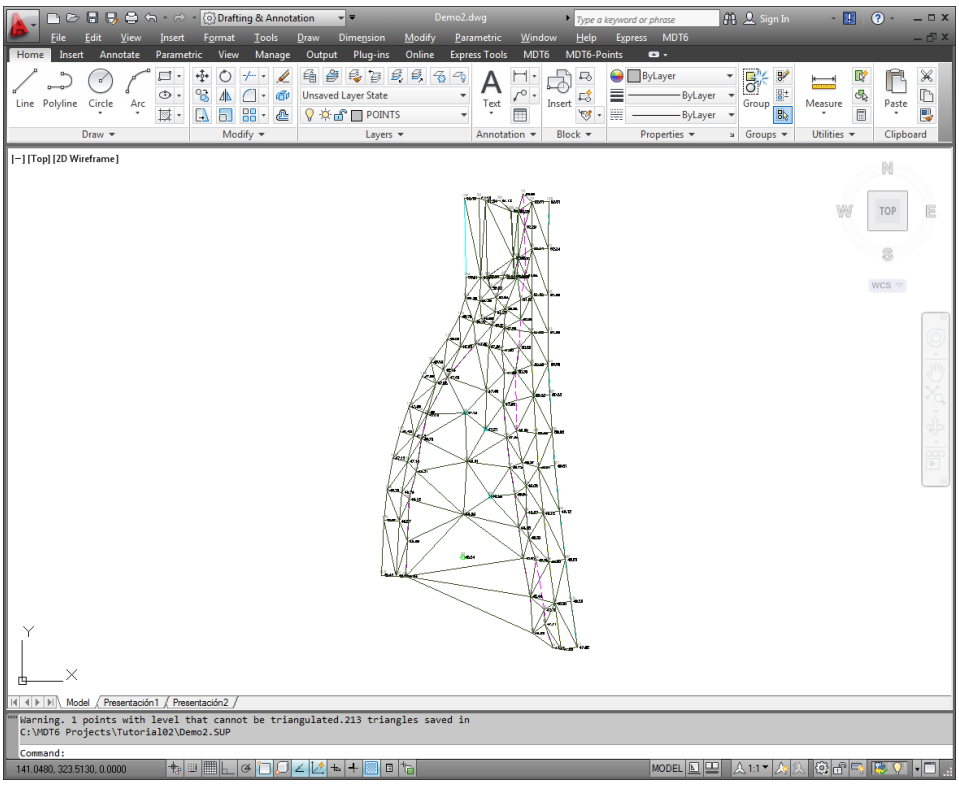
Select the **Surfaces > Create Surface** command (or in ribbon **Surfaces > Creation > Create Surface**) or, in the project window, right click on **Surfaces** and, in the contextual menu, **Create Surfaces.** Select `Demo2.SUP` as the surface to be created in the project directory. Activate the ***Points, Break Lines*** and ***Boundary Line*** check boxes if they are not already activated. Choose ***Complete*** representation.



To define the list of layers containing the break lines, click on the ***Layers*** button to the right of the ***Break Lines*** check box. In order to select a previously saved layer, click the ***Load*** button, select the `Demo2.CAP` file or manually select a layer using the > button.



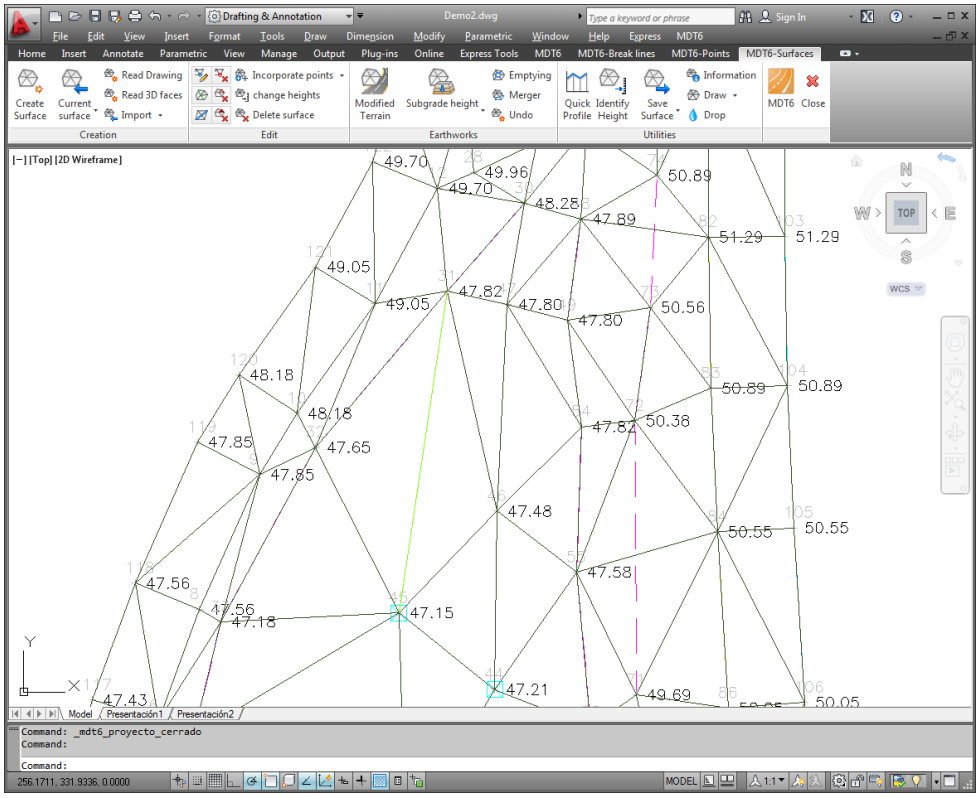
Clicking ***OK*** starts up the program's triangulation calculation process, taking all the correctly defined break lines into account. One can see in the project window that a surface file has been added.


Warning. 1 points with level that cannot be triangulated.213 triangles saved in
C:\MDT6 Projects\Tutorial02\Demo2.SUP
Command:

Editing the Triangulation

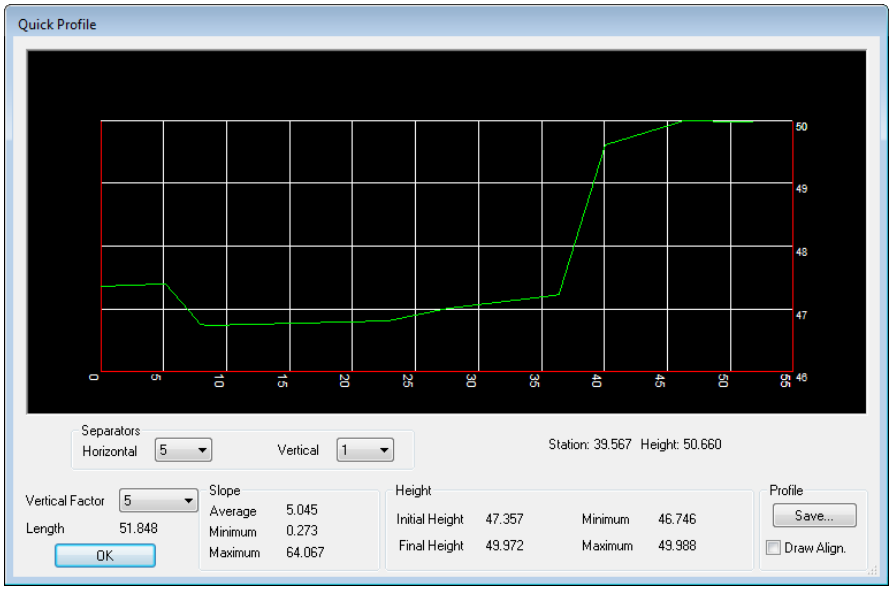
As an editing example, triangle joints in a pre-determined zone will be modified. In order to do so, execute the **Points > Locate Point** command (or in ribbon **Points > Operations > Locate**) and enter **32** for the point and use a margin of **20**.

Observing the joint between points 46 and 32, one can see it would be better adapted to the terrain if it was made up as 45 and 31. Enter **Surfaces > Insert Line** (or in ribbon **Surfaces > Edit > Insert Line**), then graphically link points 45 and 31.



Quick Profile

Next one proceeds to obtain some longitudinal and cross-section profiles that will immediately indicate the MDT formation's status. In order to do so, perform an extension zoom and use the **MDT > Quick Profile** command or in **Surface** ribbon. The first point is marked in the middle of the image on the western side. Likewise, the second point is marked in the middle of the image on the eastern side (from left to right through the center). The profile with the ends' geometric characteristics and information about these ends can be viewed on screen. Change the ***Vertical*** factor, if desired.



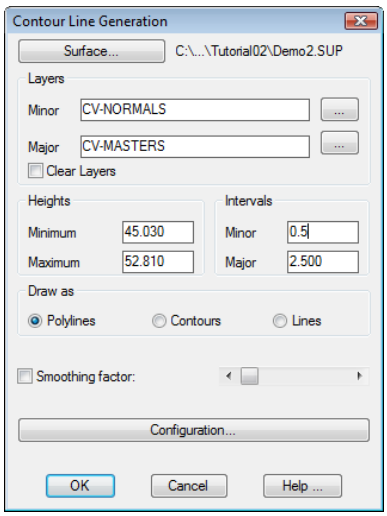
Generating Contour Lines

The DTM is accepted as valid and the contour generation process is initiated. This may suggest a new editing operation on the triangulation operation thus viewed in order to better adapt it to the known terrain's morphology.

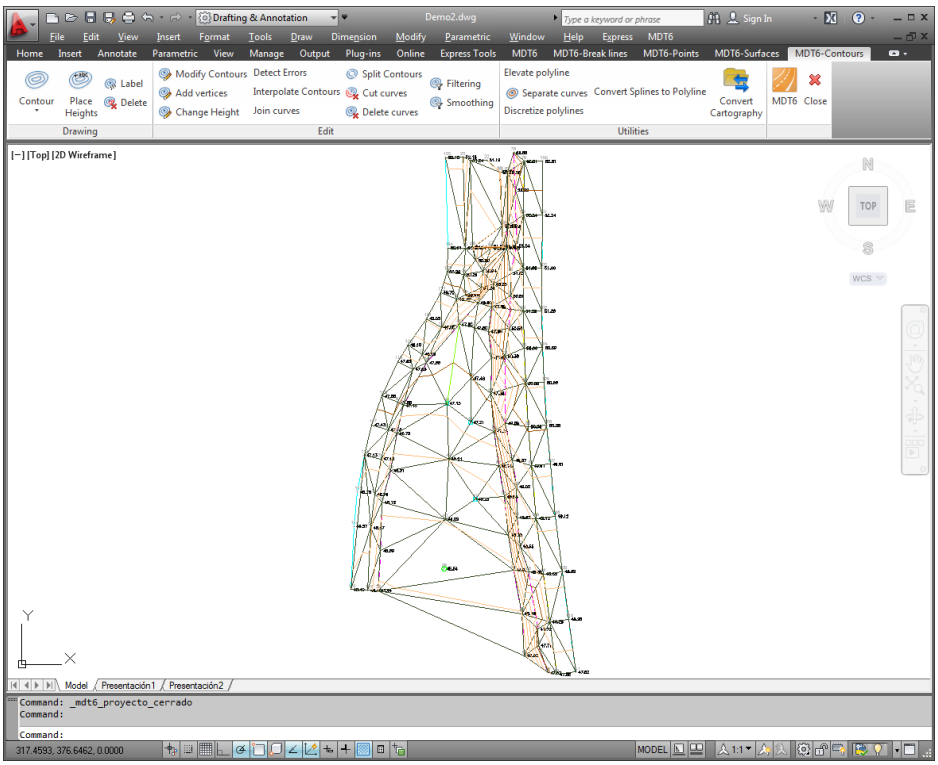
Use the **Contours > Contours** option (or in ribbon **Contours > Drawing > Contours**) or use the **Draw Contours** option in the project window's contextual menu once the surface `Demo2.sup` has been selected.

The drawing scale and the exhaustive definition of the points taken and added make it advisable to use a 0.5 meter normal contour lines with equidistant representation. Modify the ***Normal*** box by overwriting 0.500 in this field. Observe that the contour line's equivalent distance value is changed automatically to 2.500 (=0.500 x 5).

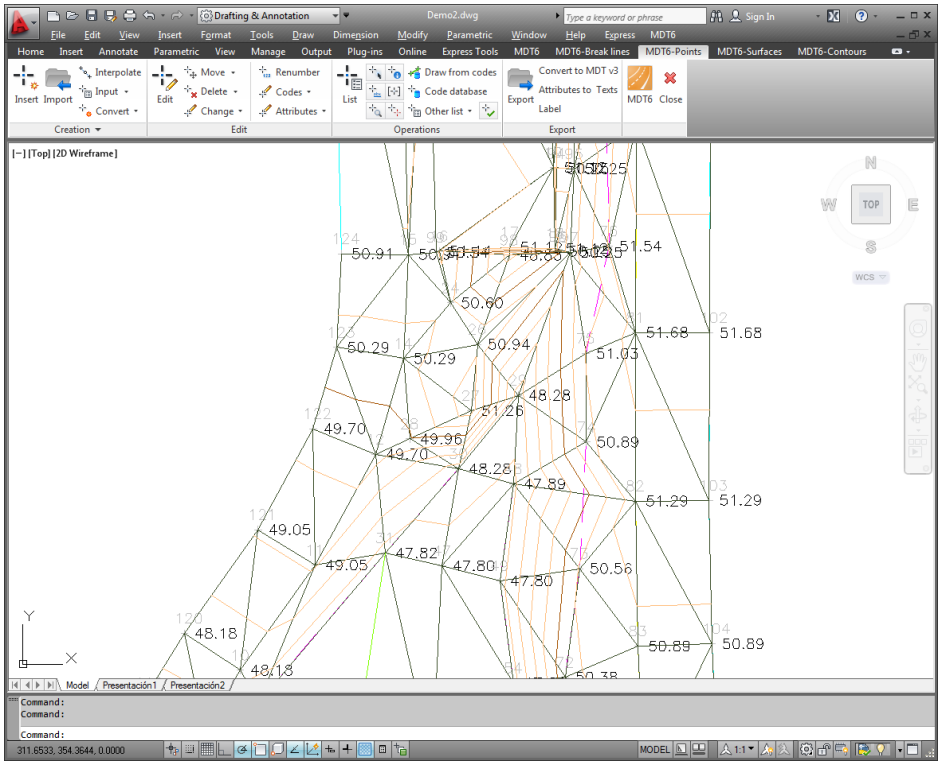
The contour lines' smoothing factor for the contours is left at 0 by leaving the ***Smoothing factor*** option unchecked. This is initially advisable, so as not to overload the drawing.



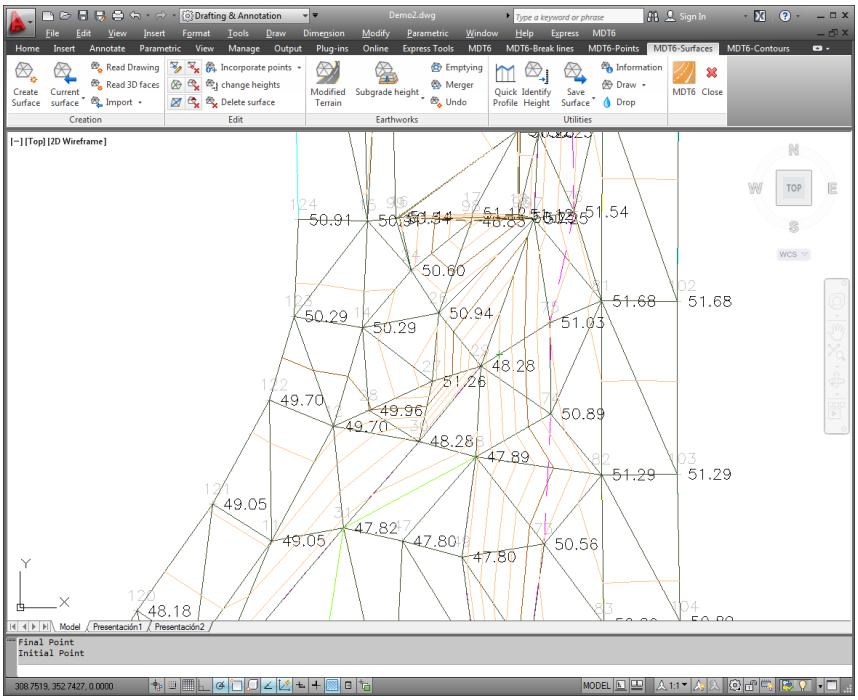
Click on ***OK*** to initiate the process



The next step is to take a detailed look at the modeling effects through their representation of contour lines. Zoom in the surroundings of point 27 using the **Points > Locate Point** command (or in ribbon **Points > Operations > Locate**).

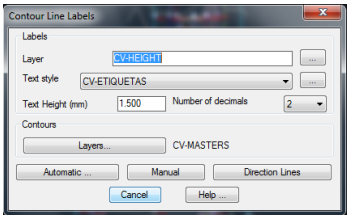


It can be seen that the contour lines set out below point 27 are choppy in the direction of point 48 and the contour line step between points 30 and 47 is avoided. This can be ironed out by inserting a triangulation line between points 31and 48. In order to do so, use the **Surfaces > Insert Line** command (or in ribbon **Surfaces > Edit > Insert Line)** and join points 31 and 48. Notice how both the contour line and the triangulation are immediately modified.

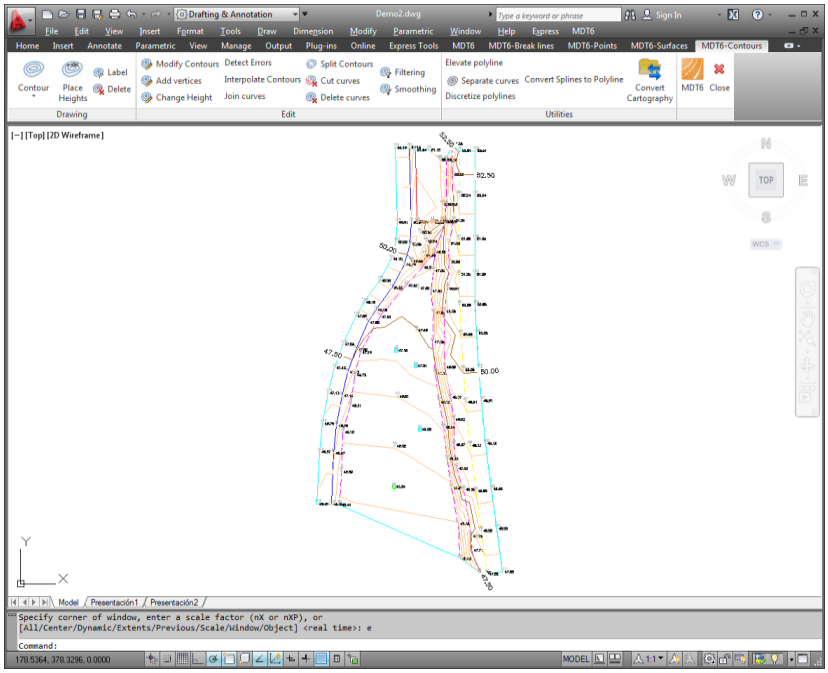


Labeling Contour Lines

If the resulting contours appear fine, the drawing can be finished by labeling the contours, smoothing and situating heights. Firstly, hide the triangulation layer (SRF-TRIANGULATION) by selecting layer 0 as the current layer or by executing the **MDT6 > View** command. Next, choose the **Contours > Labeling** command (or in ribbon **Contours > Drawing > Label**). The following dialog box is displayed:

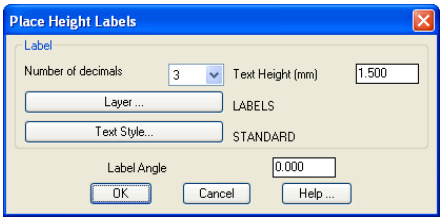


Since the contours are generated every 0.50m, it would be convenient to select 2 decimal points in ***Number of Decimals*** and in ***Text Height*** enter 1.5. Then click on the ***Automatic*** button. Perform a zoom extension.

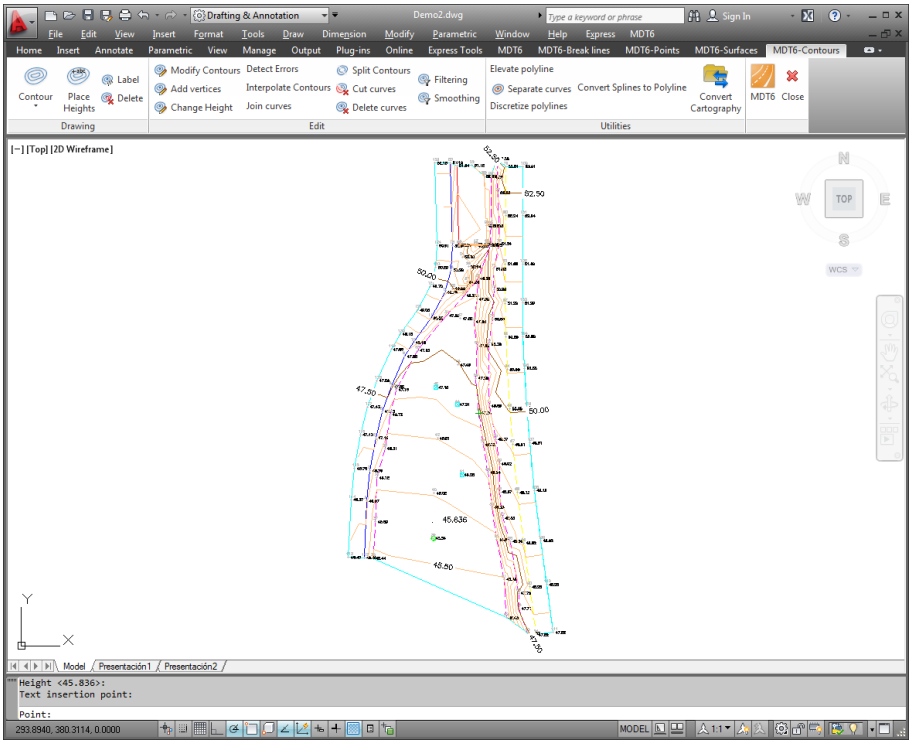


Other labels can also be drawn at the points desired. For instance, select **Contours > Labeling** (or in ribbon **Contours > Drawing > Label**), press **Manual** button and then select the last contour line in the South of the plot. The program displays the value 45.50 by merely clicking any point on the contour.

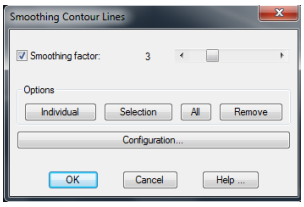
In order to project on a plane and avoid data overcrowding, a series of significant heights is placed at unique points. In order to do this, use the **Contours > Place Heights Labels** command (o bien en la cinta de opciones **Contours > Drawing > Place Heights**). Set 3 as the ***Number of decimals***, 1.5 as the ***Text Height*** and 0 as the ***Label Angle.*** Click on ***OK*** and the program then requests the point in the command area.




```
Point: 279,258 <Enter>
Height <45.836>: <Enter>
Text insertion point:  (Give some location for text)
Point: <Enter>
```



Lastly one proceeds to smooth the curves using the **Contours > Smoothing** command (or in ribbon **Contours > Edit > Smoothing**), specifying factor 3 and clicking the **All** button. Once finished, click ***OK***.



Save the drawing again using **File > Save**.

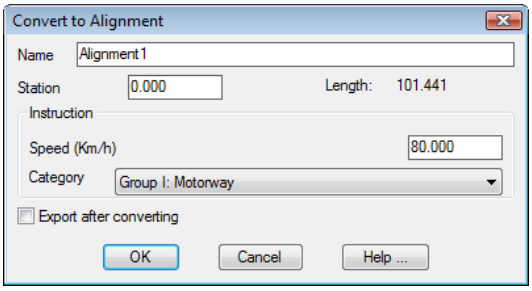
Defining the Alignment

Independently of the case described to measure earthworks, a theoretical horizontal alignment will be defined using the drawing and editing commands permitted by AutoCAD in order to practice defining horizontal alignments and profiles.

A polyline which will represent the horizontal alignment is drawn. Profiles will be obtained from it. Activate layer 0 and select the AutoCAD **Draw > Polyline** command.

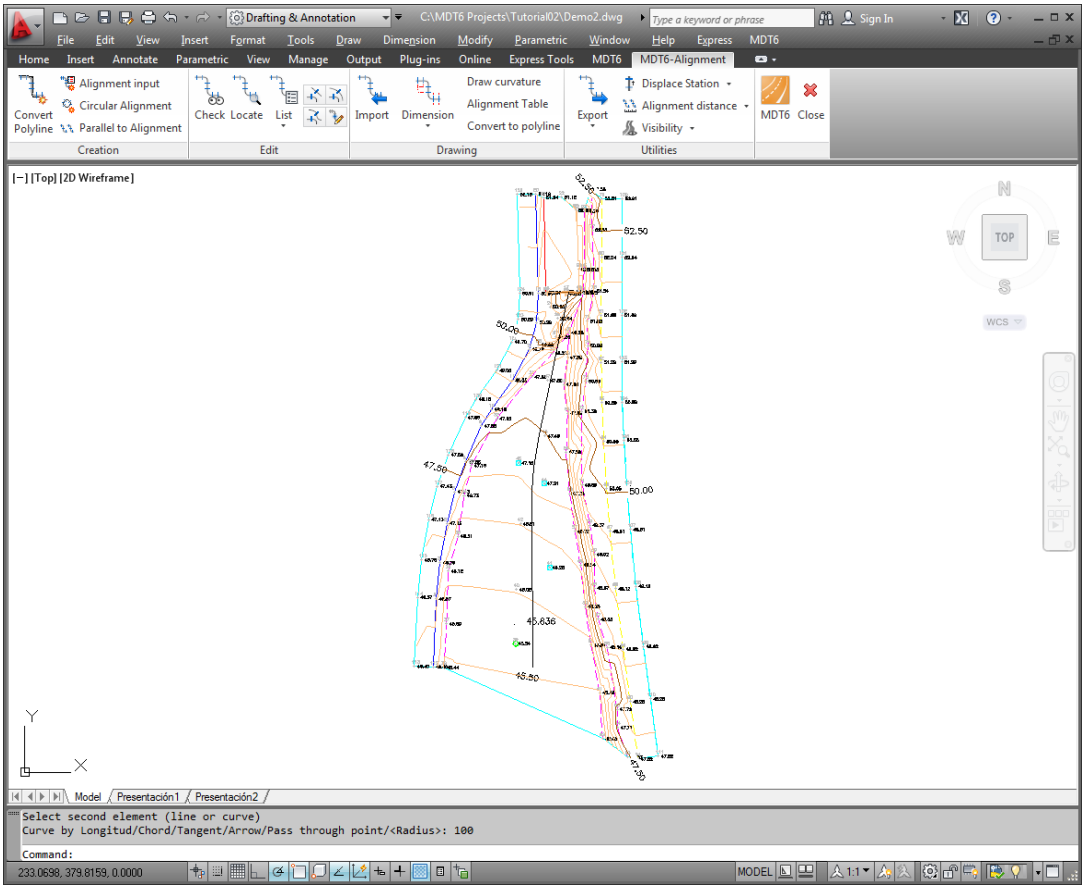
```
Specify starting point: 293.60,346.90 <Enter>
Current line thickness is 0.0000
Specify next point or [Arch/Half thickness/Undo/Thickness]:
283.50,298.30 <Enter>
Specify next point or [Arch/Close/Half thickness/Length/Undo/Thickness]:
284.00,246.50 <Enter>
Specify next point or [Arch/Close/Half thickness/Length/Undo/Thickness]: <Enter>
```

Once the polyline is designed, it can be converted into a horizontal alignment. In order to do so, use the **Alignments > Convert Polyline to Alignment** command (or in ribbon **Alignment > Creation > Convert Polyline**). Select the previous polyline by the lower end and accept the values proposed by the following dialog box.

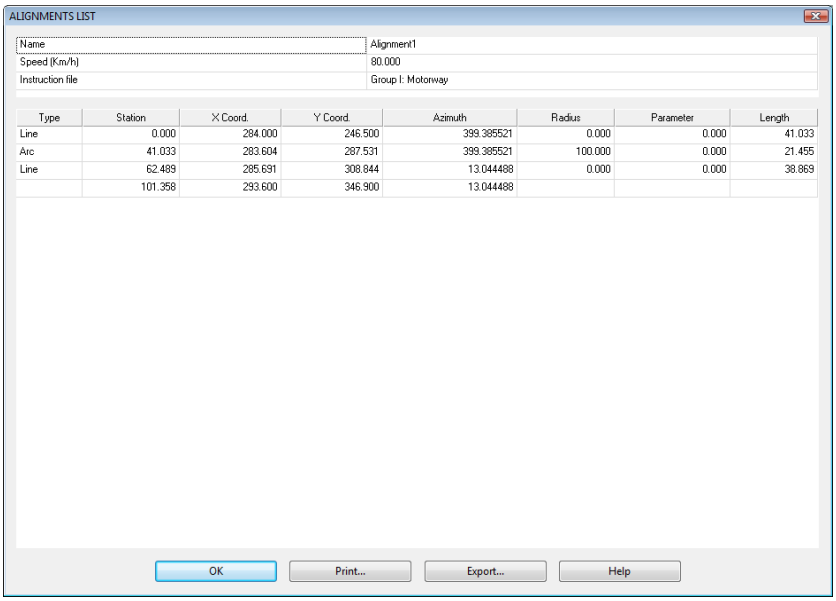


Then use the **Elements > Curves > Curve Tangential to Two Lines or Curves** command, which will allow one to insert an arch at the horizontal alignment's second vertex. In order to do this, select the first and second segments and enter the radius:

```
Curve according to Length/Chord/Tangent/Arrow/Through Point/<Radius>: 100
```



In order to know the status of the alignments defined, execute the **Alignments > List Alignment** command (or in ribbon **Alignment > Edit > List**), and select the previous horizontal alignment. The program shows an alignment status containing Station definition, X coordinate, Y coordinate, azimuth and radius.

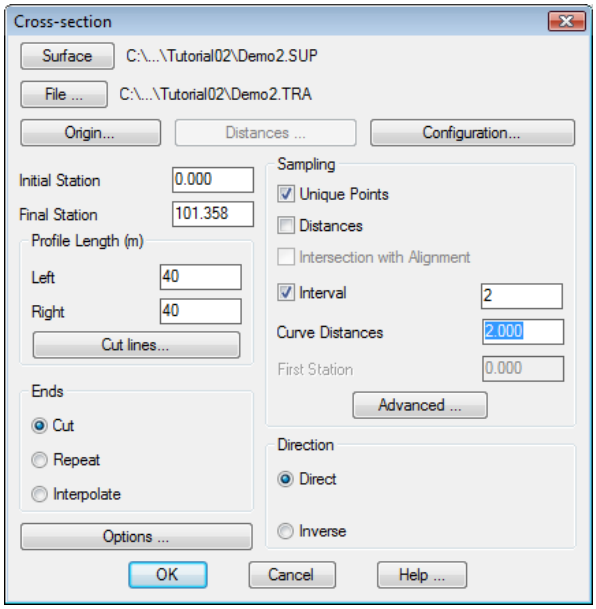


To finalize the horizontal alignment creation process, it should be saved in a file. In order to do so, use the **Alignments > Export Alignment** command (or in ribbon **Alignment > Utilities > Export**). Select the horizontal alignment graphically, click on ***OK*** in the dialog box displayed without activating any options. Then give the file the name `Demo2.EJE`. In any event, the name used will be displayed from that moment in the project window.

Obtaining Cross-Sections

We will now move on to obtain the this horizontal alignment's cross-sections. To do so run **Cross Sections > Get Cross Sections** (or in ribbon **Cross Sections > Creation > Get Cross Sections**) selecting the alignment from the drawing.

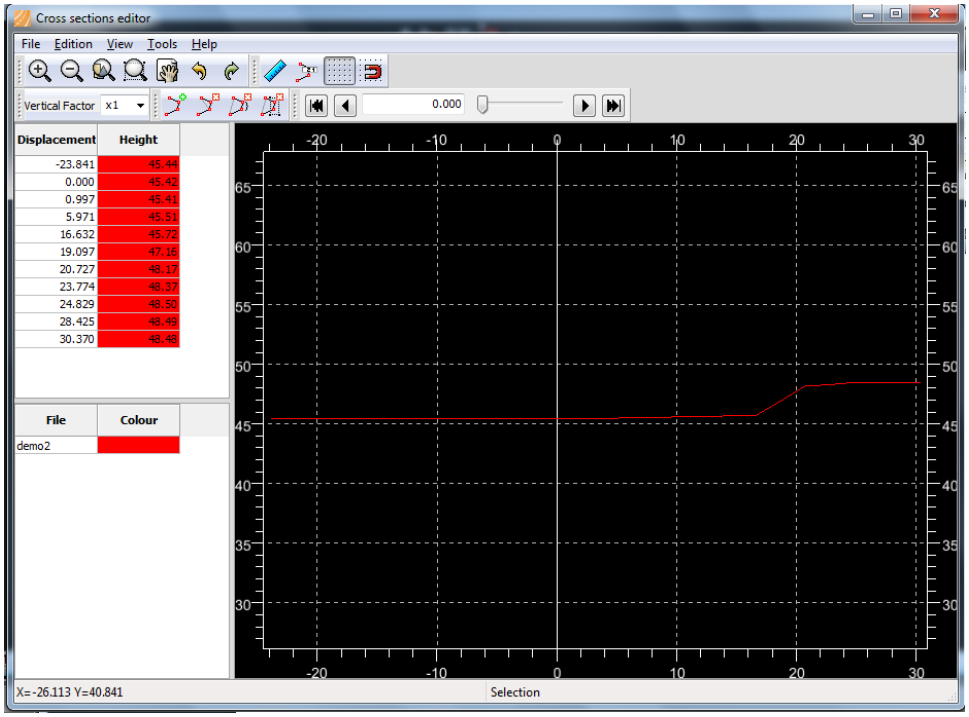
MDT proposes the `Demo2.SUP` file as the surface file in the dialog box used to obtain cross-sections. This is the drawing's current surface. It also proposes the same file name for the cross-section file with the `.TRA` extension. Lastly, one goes on to parameterize the strip's width by entering **40.00** meters in ***Left*** and another **40.00** meters in ***Right***, so that the whole model is sectionalized without the risking of missing out any areas. Activate the ***Unique Points*** check box. The profile ***Interval*** will be **2.00**, which will not lead to any problems despite being excessive.



Click on ***OK*** and a message indicating that all the profiles have been correctly generated will be displayed.

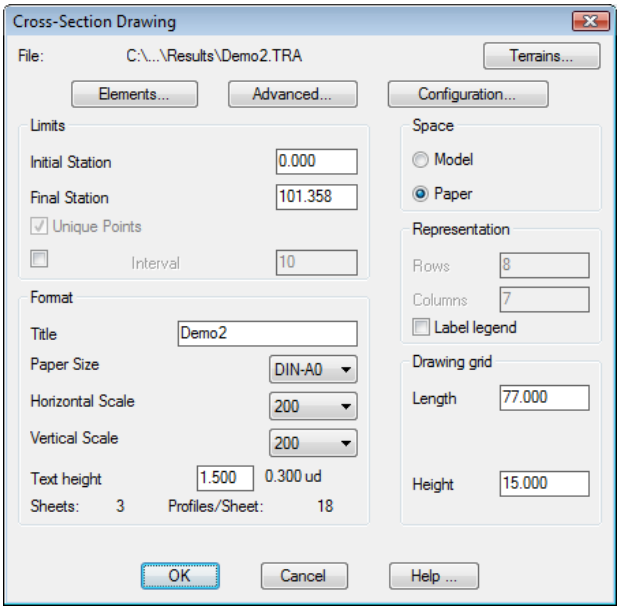
The program allows one to represent or graphically check these profiles on screen, either permanently by creating drawing objects with texts associated to each profile or quickly one by one in order to verify them by indicating the station represented and the horizontal alignment position's height. This latter option is accessed from the **Cross-Sections > Edit Cross Sections** menu (or in ribbon **Cross Sections > Check**) or its equivalent in the project window.

Select `Demo2.TRA` in the project's cross-section list window. The program will then display the profile drawings centered on a horizontal alignment. One can go forward or backwards using the ***Next*** and ***Previous*** buttons respectively.

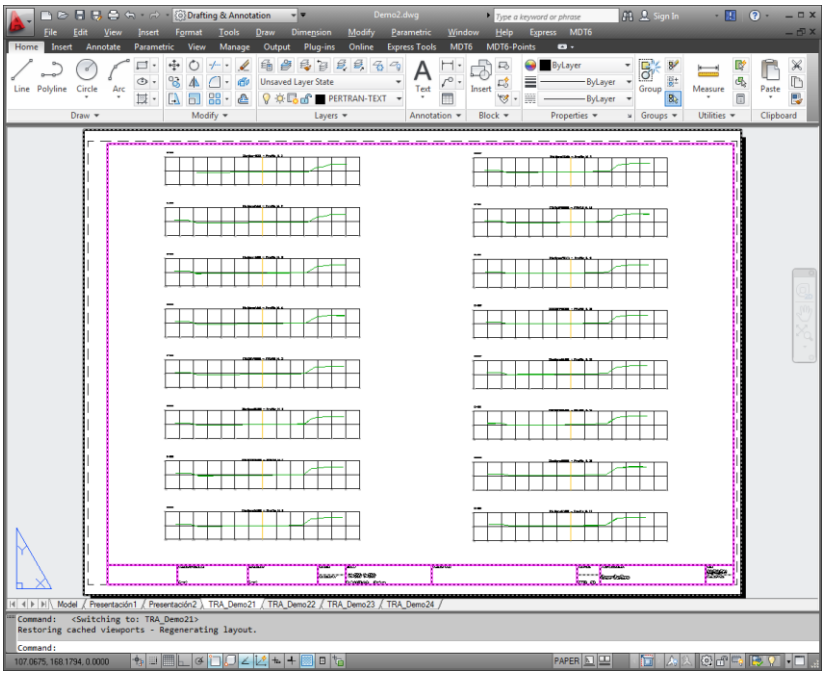


Drawing Cross-Sections

Now cross-sections will be drawn. For that run command **Cross Sections > Draw Cross Sections,** or in ribbon **Cross Sections > Drawing > Draw**, or **Draw** option in project context menu. Select format ***DIN-A0*** from the format list, ***Model*** space and ***Demo*** for the title. Click ***OK***.



New paper space representations will then be automatically created, each corresponding to a sheet of paper.



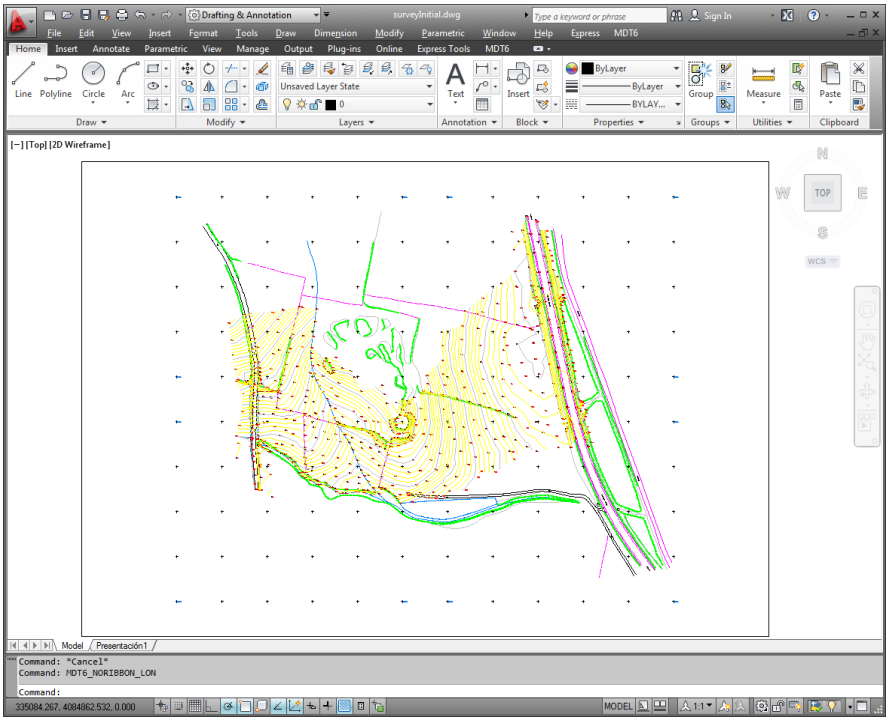
Once this process is finalized, the drawing should be saved again using the AutoCAD **File > Save** command.

Tutorial 3. Volume Calculation

Computing Cross Sections

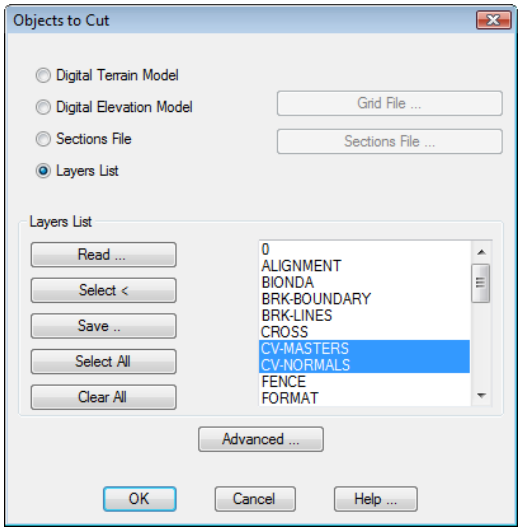
In this tutorial we will learn two different methods for computing volume between original terrain and modified terrain: by cross sections and by grids.

Open drawing `surveyInitial.dwg` that can be found in folder `C:\MDT6 Projects\Tutorial03`.

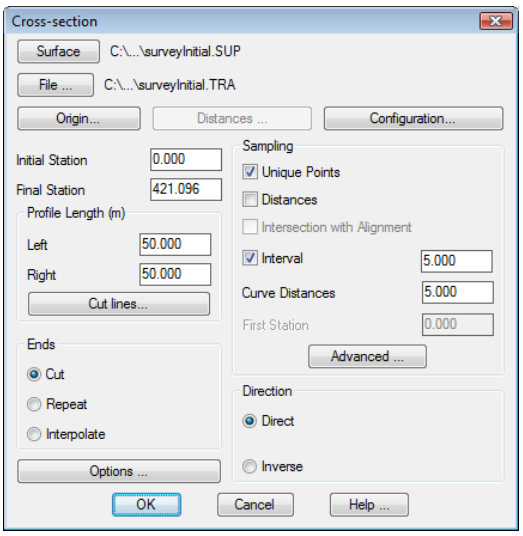


We must import the alignment that will be used for cross sections generation. In this case we will import `Alignment1.eje` located at the same folder. Run command **MDT6 > Alignment > Import Alignment** (or in ribbon **Alignments > Drawing > Import**).

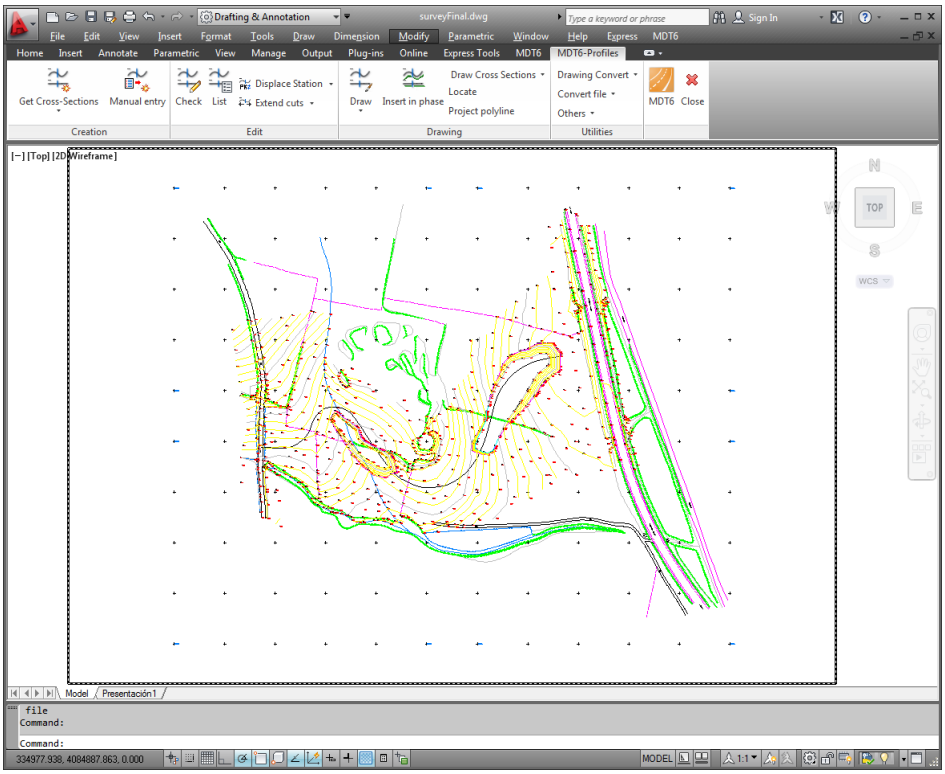
Once imported the alignment, we will get cross sections with command **MDT6 > Cross Sections > Get Cross Sections** (or in ribbon **Cross Sections > Creation > Get Cross Sections**) from contours. Select alignment in the drawing and press button **Origin**. Choose **Layer List** and select from list layers CV-MASTERS and CV-NORMALS.



Press ***OK*** and enter parameters as shown in the following dialog. The new cross sections file will be named `surveyInitial.TRA`.

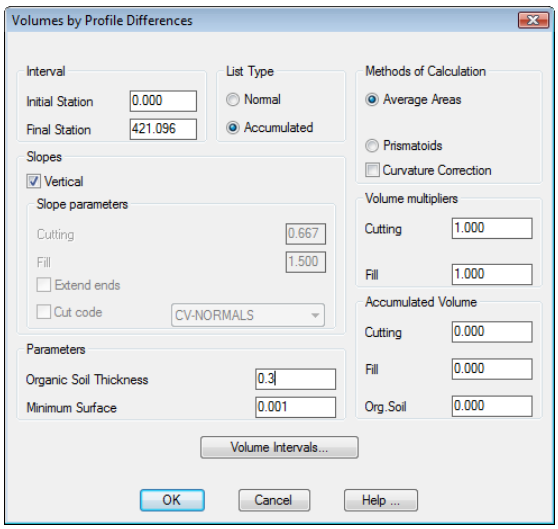


Open drawing `surveyFinal.dwg`, generating cross sections from surface `surveyFinal.sup` (default option **Digital Terrain Model** in **Origin** dialog). To get the cross sections, we must select the alignment already drawn and give the same parameters that for initial survey. The cross sections file will be named `surveyFinal.tra`.

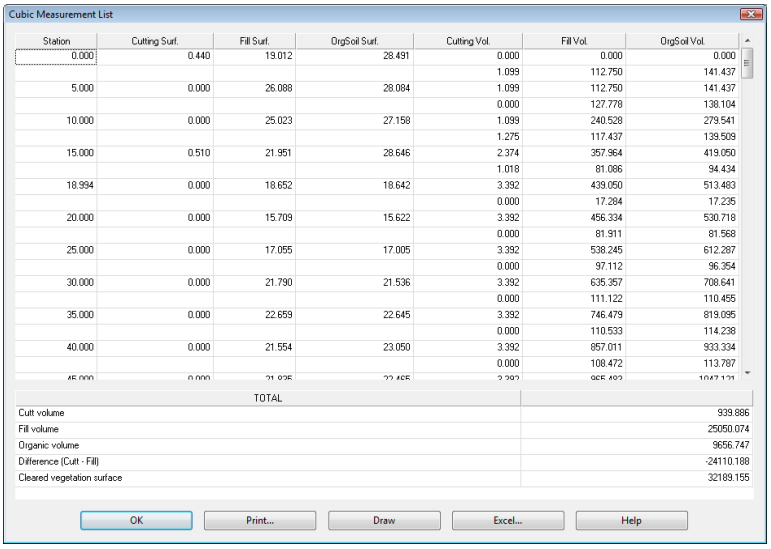


Volume by Cross Sections Differences

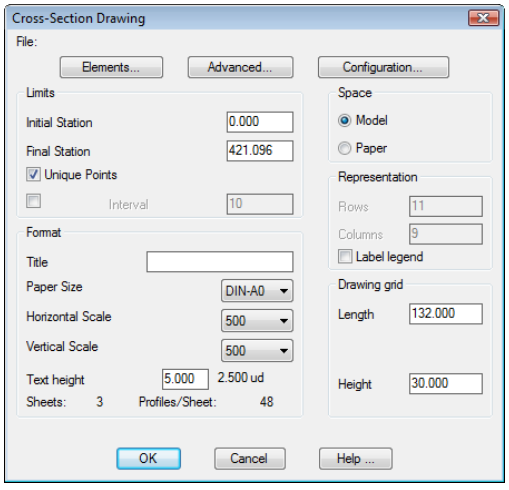
We can obtain the result of the mediation between both profiles with the **Volume > Cross Sections Difference** command (or in ribbon **Volume > Difference Profiles**). This shows a selection window for the first profile file, which is `surveyInitial.TRA`. After validating this one, choose the second one as `surveyFinal.TRA`. The following dialogue box appears next. In this we can configure the capacity report. The initial station will appear as **0.000** as it is the first slice common to both profiles. We type **0.3** as organic soil value.



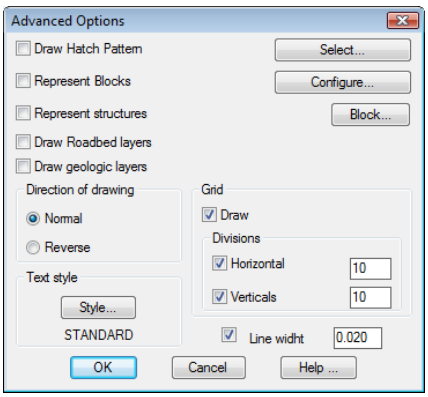
The program will calculate the cut and fill volumes, and show on the screen a list of partial and accumulated volumes.



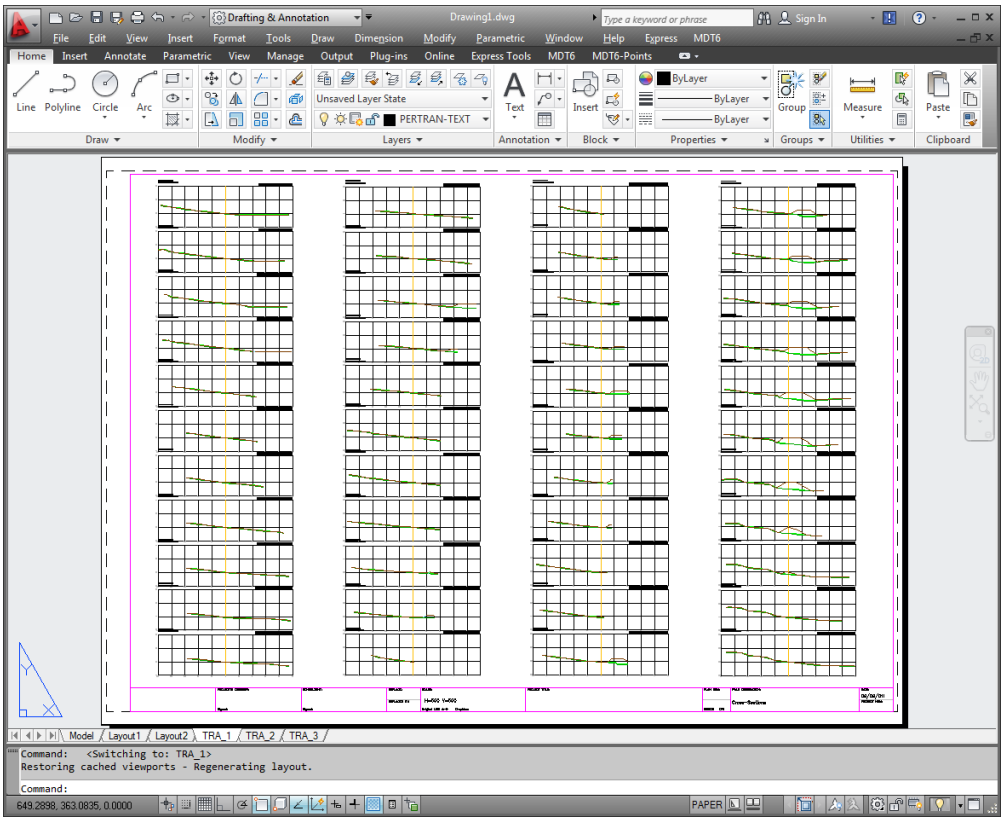
Press **Draw** button and select **DIN-A0**, **Model Space**, **Horizontal Scale 500** and **Vertical Scale 500**.



Press **Advanced** button, and enter values of **10** meters **for Horizontal Division** and **5** meters for **Vertical Division**.

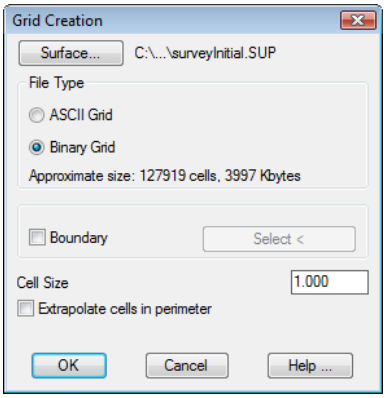


Press OK two times. The cross sections will be drawn distributed in three sheets.



Volume by Mesh Difference

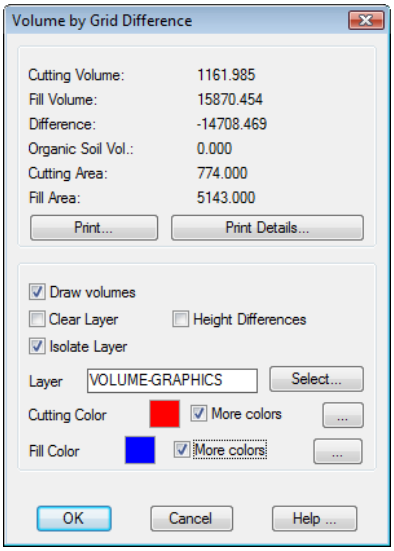
Now we will make another comparison using another method of volume calculation. Activate again drawing **surveyInitial** and then run command **Grids > Create Grid from Surface** (or in ribbon **Grids > Creation > Grid from Surface**), and select surface file `surveyInitial.sup`. Set **Binary Grid** as the file type in the dialog box and cell size at **1** m. Save the information in the `surveyInitial.MDE` file.

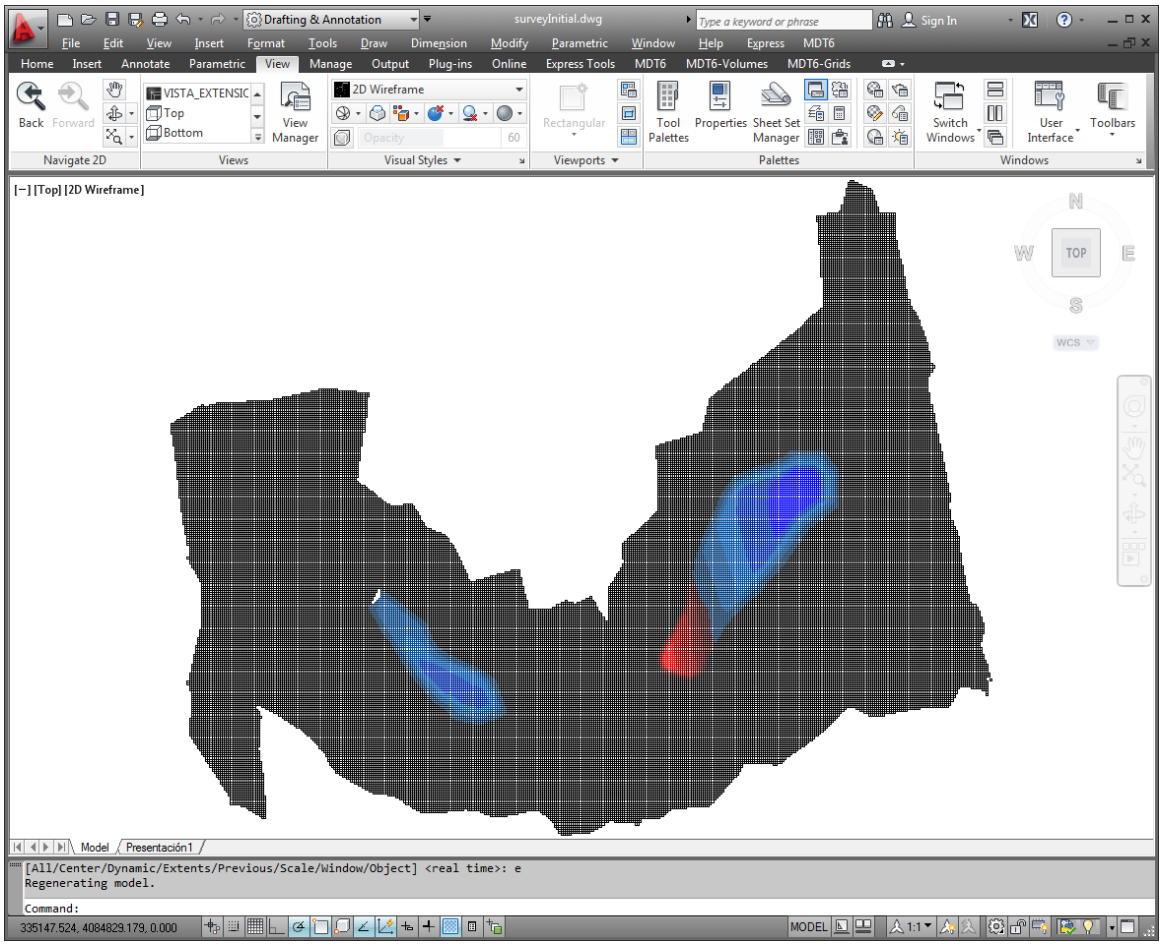


Now we perform the same operation with drawing **surveyFinal** and surface `surveyFinal.sup`, generating grid file `surveyFinal.MDE`.

Next choose the **Volumes > Grid Difference** command (or in ribbon **Volumes > Terrains > Difference Grids**) and press **OK.** Select the two files generated previously in the same order.

In the following window appear the final results, with the possibility of drawing a mesh with the final result. Activate the **Draw Volumes, Isolate Layer** and **More Colors** check boxes. Click on **OK**.





File Summary

Once the job is finished we save all the files in the `C:\MDT6 Projects\Tutorial03` folder. The main files are as follows:

File	Description
`surveyInitial.DWG`	Original terrain drawing
`surveyFinal.DWG`	Modified terrain drawing
`Alignment1.EJE`	Alignment
`surveyInitial.SUP`	Original terrain surface
`surveyFinal.SUP`	Modified terrain surface
`surveyInitial.TRA`	Original terrain cross sections
`surveyFinal.TRA`	Modified terrain cross sections
`surveyInitial.MDE`	Original terrain binary grid
`surveyFinal.MDE`	Modified terrain binary grid

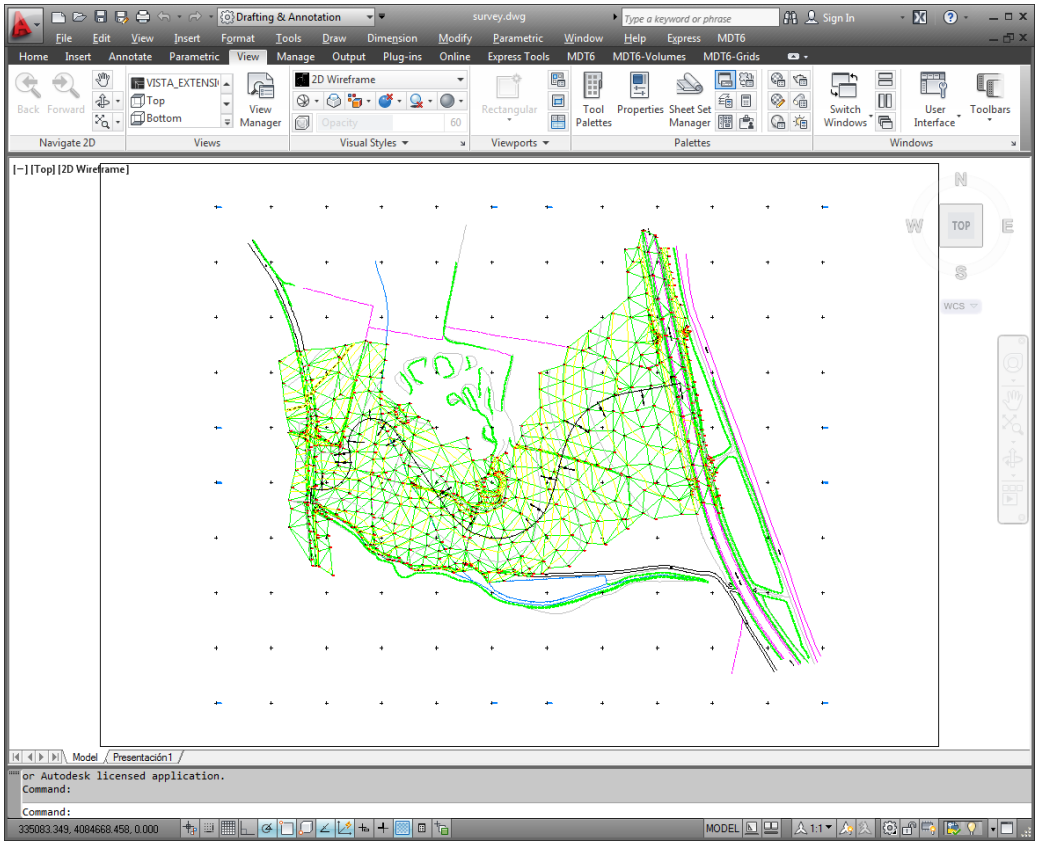
Tutorial 4. Road Design

In this example we will start from a survey already triangulated and with contours lines drawn. From this we will obtain longitudinal and cross section profiles from an alignment, again, already in existence. We will generate the widenings and superelevations and we will define a grade line. We will then associate a template and create the segment for all this data. From the segment we will build the digital modified terrain model and we will generate the different volume lists.

We will also use the setting out tools. For the correct comprehension of these processes, it is advisable to have worked through the previous examples in this **User Manual**.

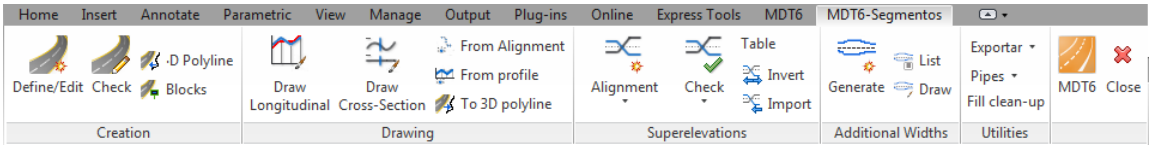
Project Selection

Firstly, open the drawing `survey.dwg` in the `C:\MDT6 Projects\Tutorial04` folder.

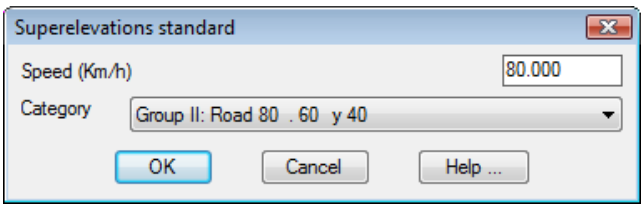


Superelevation and Widening Generation

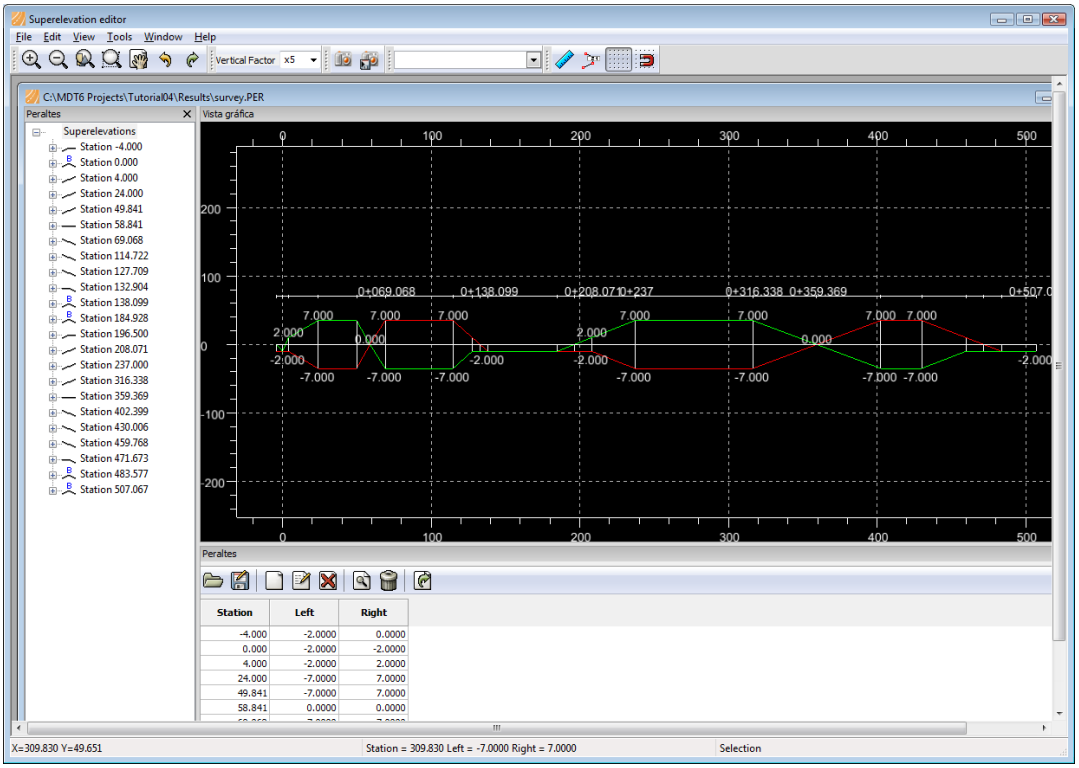
If we are using AutoCAD 2010 or higher, activate **Segments** ribbon to have access to the commands for superelevations and widenings.



To generate superelevations related to the alignment run option **Segments > Superelevations > Generate Superelevations from Alignment** (or in ribbon **Segments > Superelevation > Alignment > Alignment**). Select alignment in drawing and next dialog will appear. Select group 2 and give as file name `survey.per`.

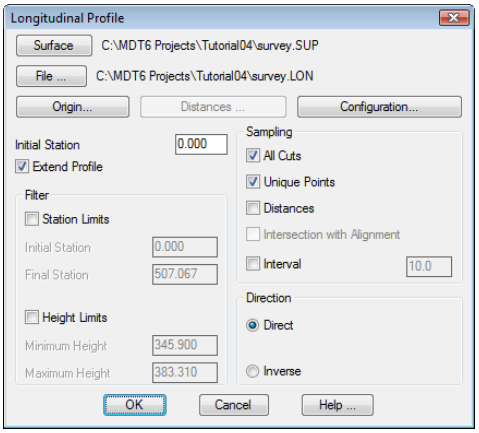


To visualize it, run command **Segments > Superelevation > Check Superelevations** (or in ribbon **Segments > Superelevations > Check**) and select file generated.

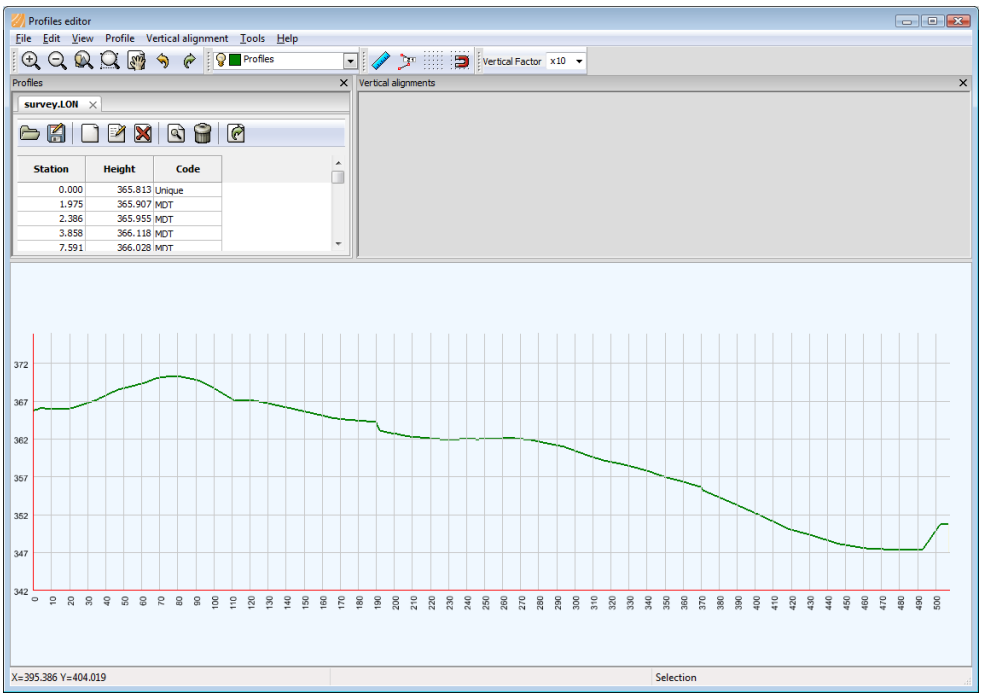


Obtaining Longitudinal Profiles

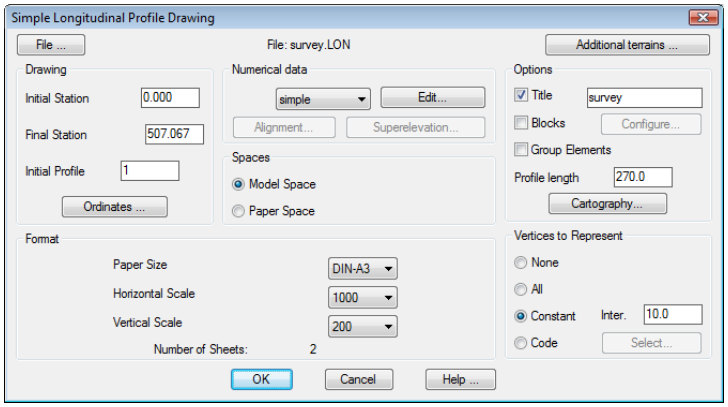
To get profiles, run command **Profiles > Get Profile** (or in ribbon **Profiles > Creation > Get Profile**). Enter **File** option and choose `survey.EJE`. Activate, if it has not already done, the ***Unique Points*** box and the ***All Cuts*** check box, and deactivate the ***Interval*** box. Click ***OK***.



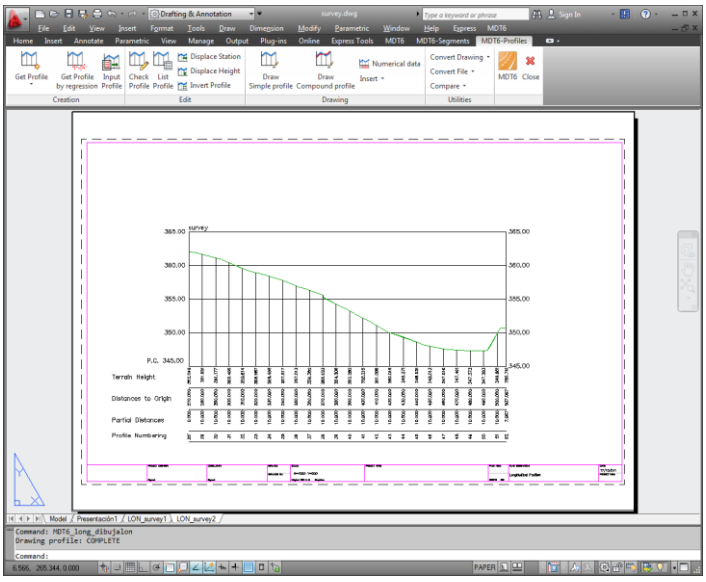
The longitudinal profile thus generated can be viewed by selecting the new file within the Profiles category, running commando **Profiles > Check** (or in ribbon **Profiles > Edit > Check Profile**)



Next we run command **Profiles > Draw Simple Profile** (or in ribbon **Profiles > Drawing > Draw Simple Profile**) and select generated file. Next, select **Paper Space, DIN-A3** format, **Horizontal Scale 1000** and **Vertical Scale 200**, and **Constant Interval** with the value **10**.



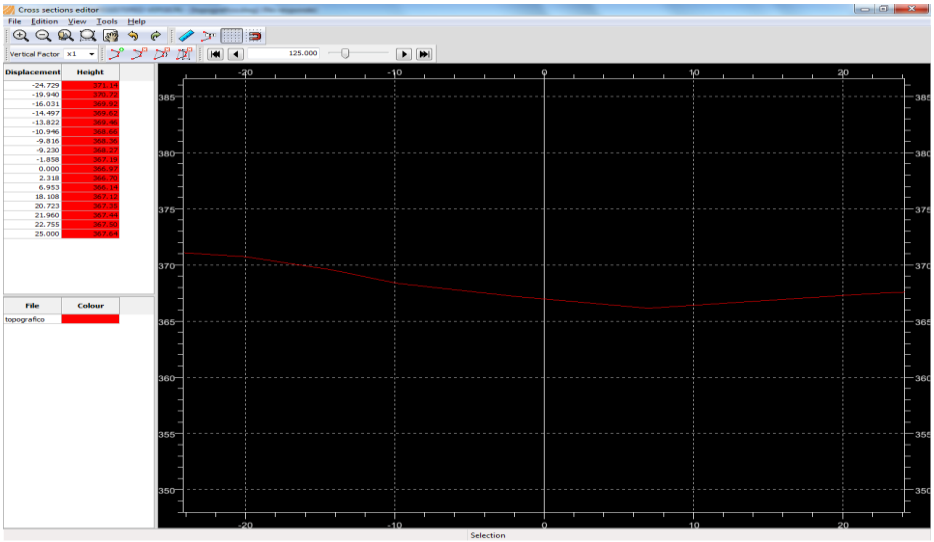
Click ***OK***. Two presentations with the prefix LON_survey will be created.



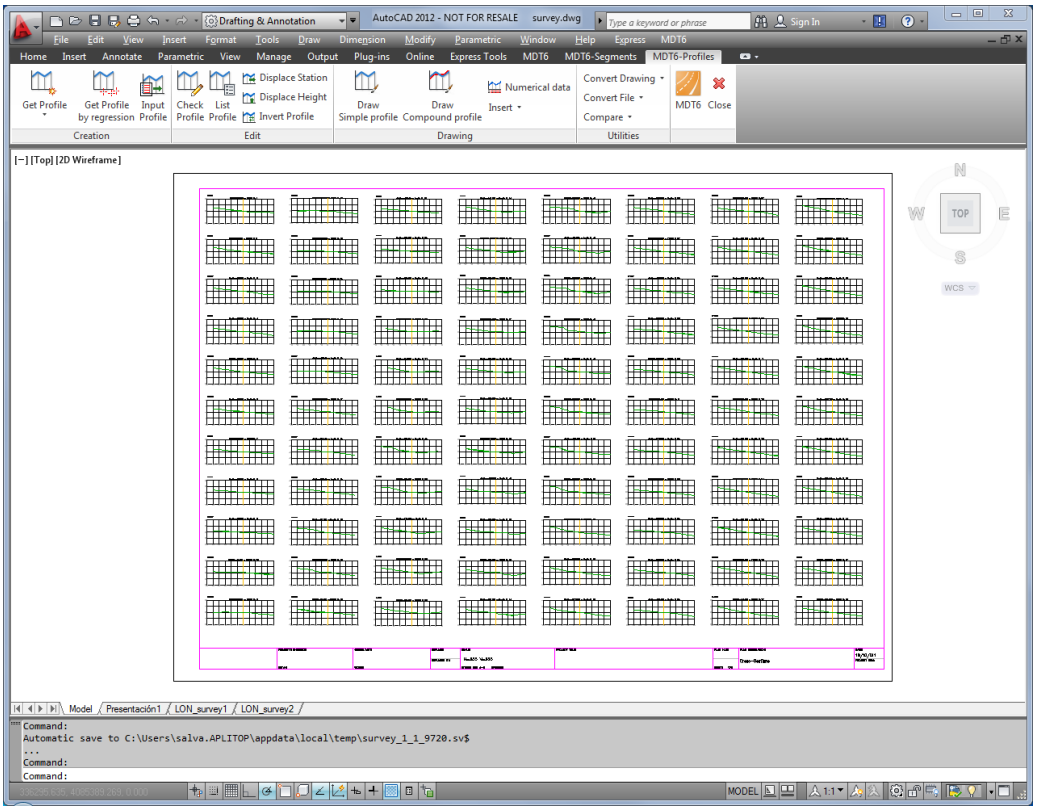
Obtaining Cross-Section Profiles

Likewise, in order to obtain the cross-sections, run command **Cross Sections > Get Cross Sections** (or in ribbon **Cross Sections > Creation > Get Cross Sections**). The cross-sections will be saved by default in the `survey.TRA` file in the same folder as the current folder. Choose an **Interval** of **5** and a **Left** and **Right** distances of **25**. Activate the **Unique Points** check box. A message will be displayed indicating that all the profiles have been correctly generated.

In order to view the different profiles generated, run command **Cross Sections > Edit Cross Sections** (or in ribbon **Cross Sections > Edit > Check**) and select generated file.

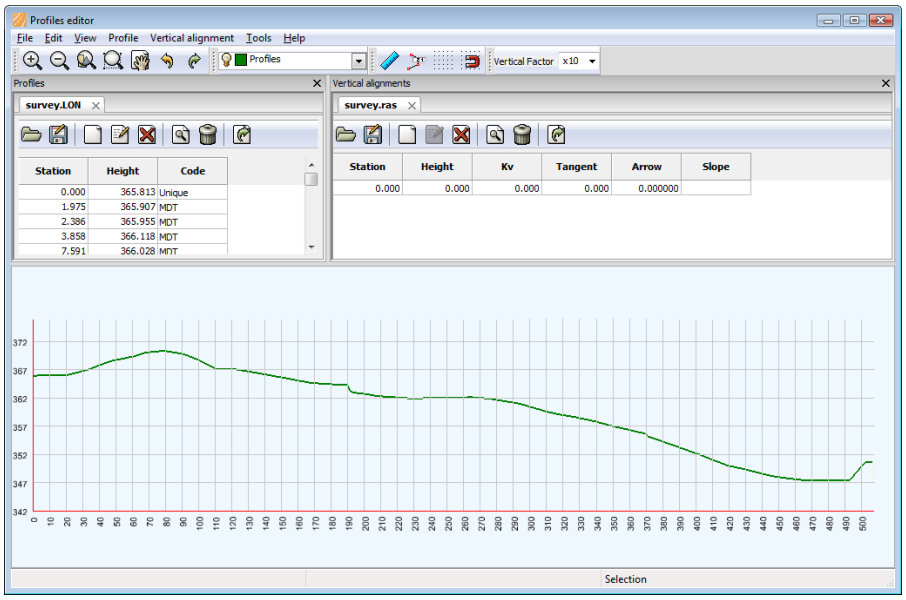


Run **Cross Sections > Draw Cross Sections** (or in ribbon **Cross Sections > Drawing > Draw**). Set as parameters **DIN-A0** format, horizontal and vertical scale **500** and **Model** space.



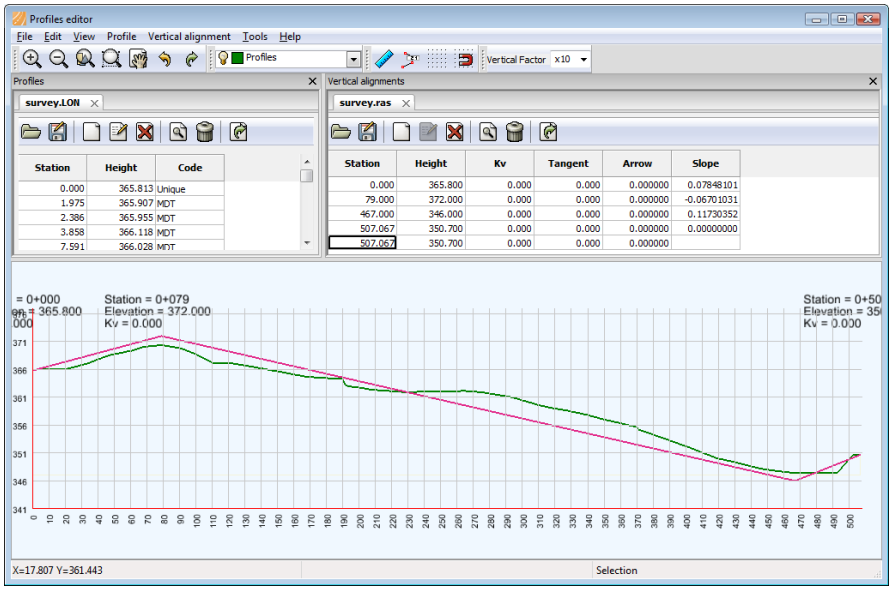
Vertical Alignment Definition

For the definition of the grade previously we define its vertices, without entering vertical curves, by running command **Profiles > Edit Profile** (or in ribbon **Profiles > Edit > Check Profile**) and selecting file `survey.lon`. Then in the editor window run **Vertical Alignment > New** and set as new file name `survey.ras`.

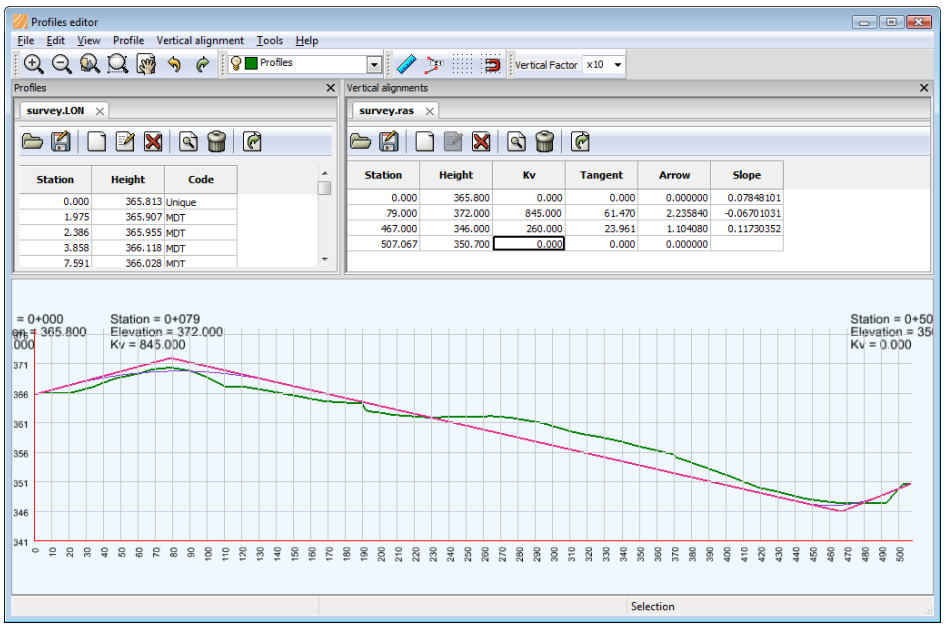


Once created the new vertical alignment, we define each of its vertices, by entering in the upper right area of editor the following data:

Station	Height
0.000	365.800
79.000	372.000
467.000	346.000
507.067	350.700



Now we are going to define the vertical curves, by entering their parameters of two parabolas, with a parameter (KV) of **845** for the second vertex and **260** for the third. Observe that when validating data the tangent and arrow parameters are calculated automatically.



To end the vertical alignment definition close the window saving the changes in file `survey.ras`.

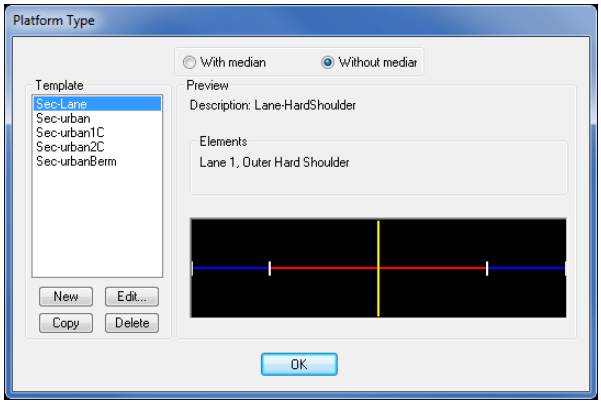
Template Definition

Before obtaining a complete set of cross sections, we must specify the templates associated with our road. The program incorporates libraries of platforms, ditches and roadbeds. This library can be added to and customised.

We will use these elements for the sake of learning.

Platforms

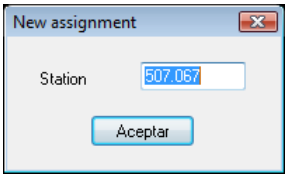
To start run command **Templates > Define/Edit** (or in ribbon **Templates > Creation > Define/Edit**), give as new file name `survey.scc` and the following dialog will appear, in which we can find a number of platforms which can be customised for our needs.



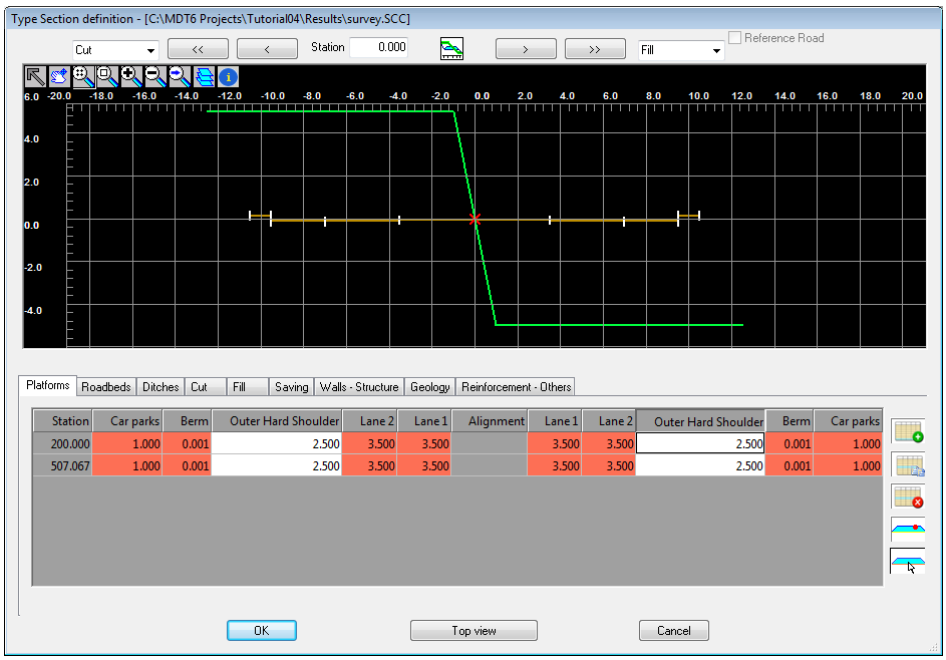
Select template **Sec-Urban2C** and press **OK**. Then select the alignment by selecting it in the drawing or entering **F** option and choosing the `survey.eje` file.

Next a window will appear for definition of the elements that compose our template. The aim is to define a road in which after 200 meters will have a sidewalk with curb up to the final station of alignment.

Press insert button , and a new window will appear with final station of alignment. Validate it and a new assignment will be created automatically.



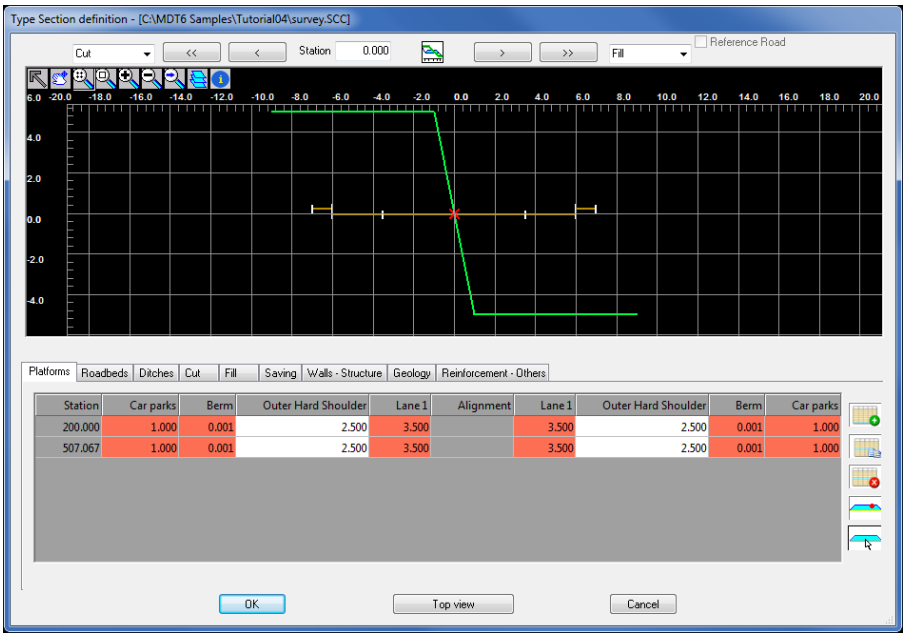
Equally we are going to insert the same assignment for station **200** pressing again the same button.



Once we have the same assignment in the stations desired we can modify the values of every vector in each of stations, as appear in the following image.

Sometimes it's needed to change the superelevation of some elements. If we move the cursor over the heading of every column and press the mouse right button, we find the option to **Activate / Deactivate Superevation.** Camberable vectors appear in pink color.

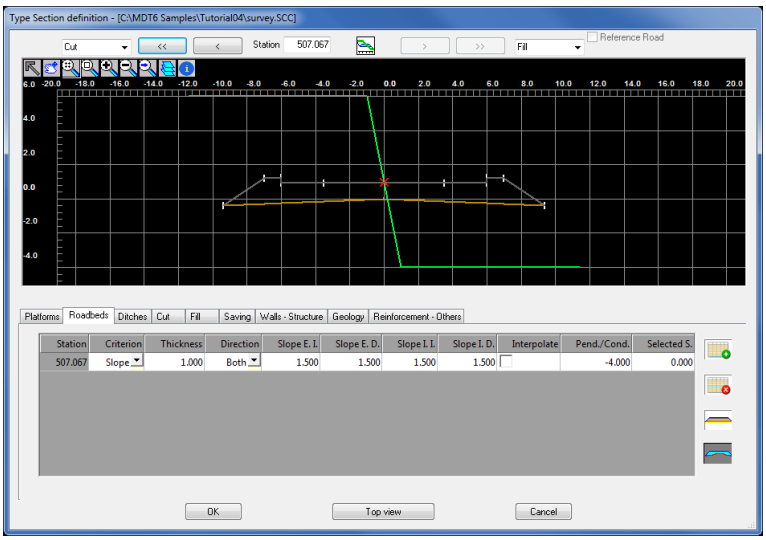
Once defined the platform we see that really we only need a lane at every side instead of the two that appear. To remove the lanes move the cursor over **Lane2** and press **Remove.** Repeat this at both sides of alignment. Assignement of platforms will be as shown in the image.



Roadbeds

For roadbeds definition, activate the tab with the same name, and press Insert button to create a new assignment up to last station.

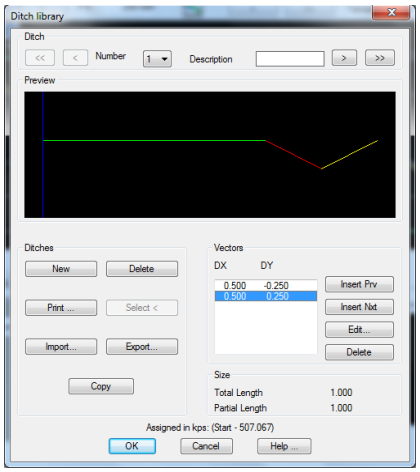
In assignment we will change the thickness by the value of 1. The **Criteria** will be changed to **Slope** and the value of **Slope** to **-4.000**. The final result will be shown in the following window.



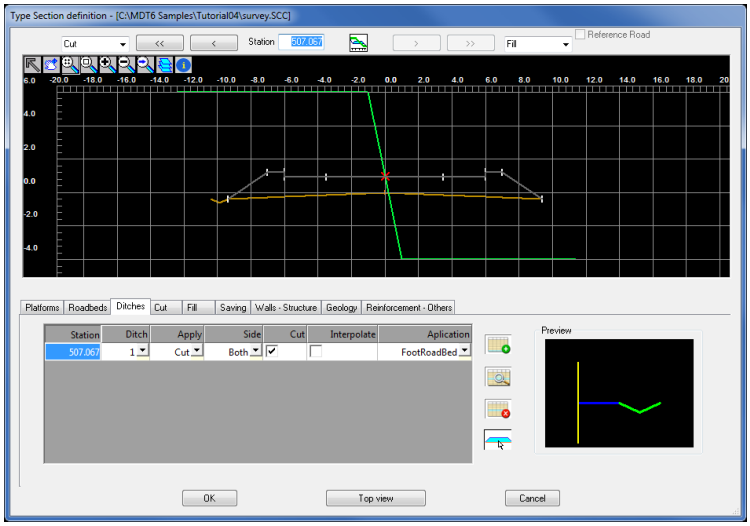
Ditches

To define the ditches, click on the ***Ditches*** button in the **Templates** dialogue box. Press Insert button and a set of predefined ditches will appear. We can add new ditches or modify existing ones.

In this case we are going to use ditch number **1**, but with an additional vector. Press **Insert Nxt** button and assign to new vector values **0.5** in X and **0.25** in Y.

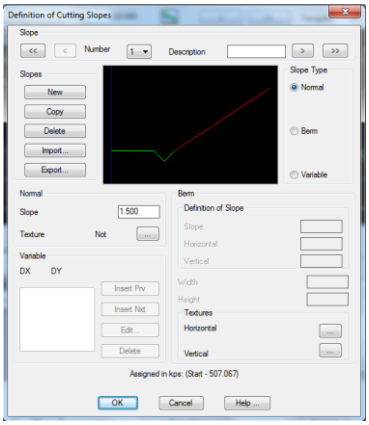


Once validated the window, the program will ask for the station to assign, and we must select **Final Station**. It will be seen in the drawing of the template does not appear. This is because the slopes has not been defined yet and there is not cut with ground.

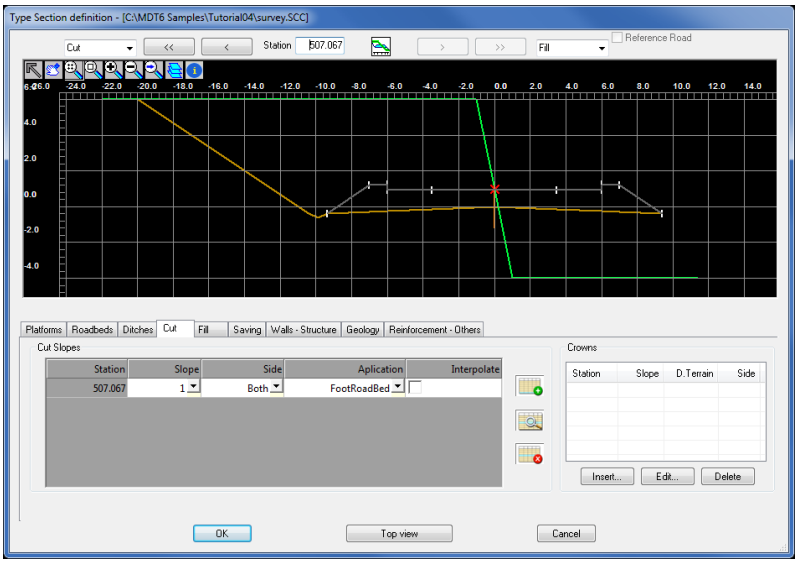


Cut Slopes

To define the cut slopes, activate the **Cut** tab and press **Insert** button. Then the following window will appear, where we must select the slope to insert. In this case select first one, which has a fixed value of **1.5**.

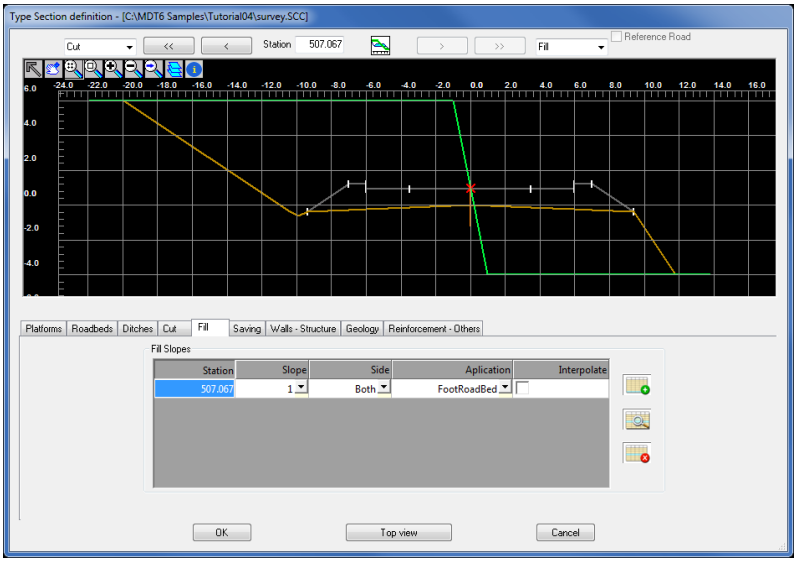


Finally the slope assignment will appear as shown in the following image:



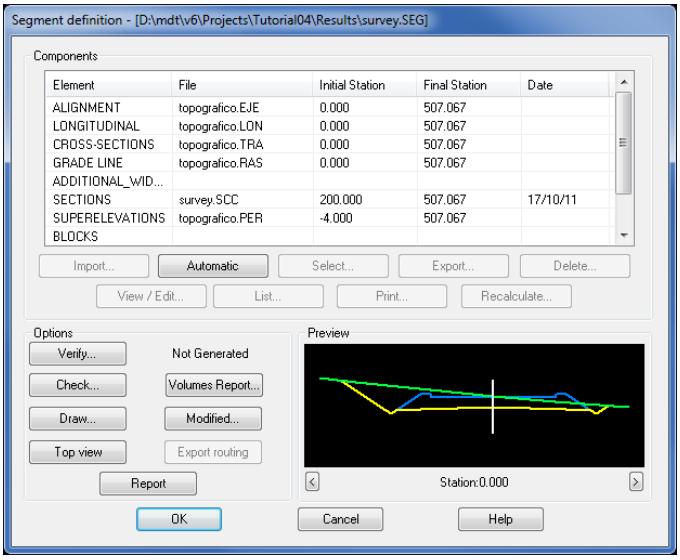
Fill Slopes

Now we proceed in the same way for fill slopes. In this case the value of slope will be **0.667**.



Once defined the template completely as well as the other items that compound the segment (horizontal and vertical alignment, profiles, cross sections…) we can group all so that it will be possible to work with a single file that groups all of them.

To do so run the command **Segments > Define/Edit** (or in ribbon **Segments > Creation > Define/Edit**) and give as name of new file `survey.seg`. Then we will import successively files `survey.eje`, `survey.lon`, `survey.tra`, `survey.tra`, `survey.scc` and `survey.per`.



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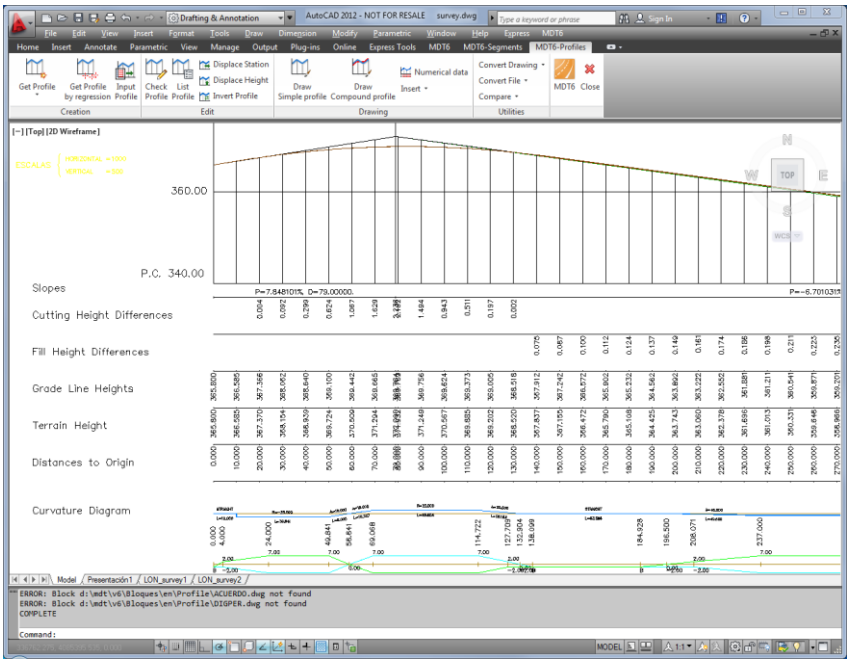
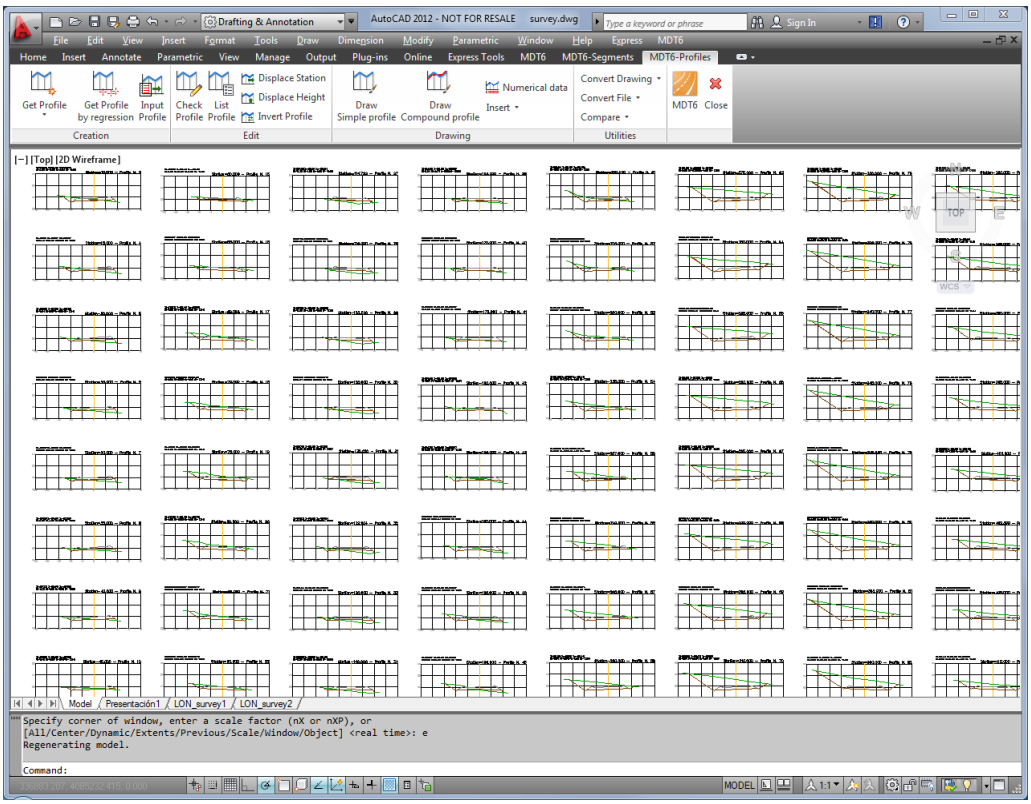
Drawing Profiles

Now we can completely represent the longitudinal and cross section profiles. In the MDT6 menu select **Segments > Draw Longitudinal Profile** (or in ribbon **Segments > Drawing > Draw Profile**) and choose file survey.seg. Set **1000** and **500** as the ***Horizontal*** and ***Vertical*** scale values respectively and set the value of **10** as the ***Constant*** interval. Click on ***OK***.



On the other hand, to draw the cross sections run command **Segments > Draw Cross Sections** (or in ribbon **Segments > Drawing > Draw Cross Sections**) and choose file `survey.seg`. Set as paper format **DIN-A0**, horizontal and vertical scale **500**, title **Survey** and **Model Space**. Press **OK** and several sheets will be drawn with cross sections.



Save the drawing as `survey.DWG`, in the `C:\MDT6 Projects\Tutorial04` folder.

File Summary

Once the work has been finalized, the existing project files should be numbered in the aforementioned folder. The files are the following:

File	Description
`survey.DWG`	Original terrain drawing
`survey.EJE`	Horizontal alignment
`survey.LON`	Original terrain longitudinal profiles
`survey.TRA`	Original terrain cross sections
`survey.RAS`	Vertical alignment
`survey.PER`	Superelevation associated with the original alignment
`survey.SCC`	Templates
`survey.SEG`	Segment

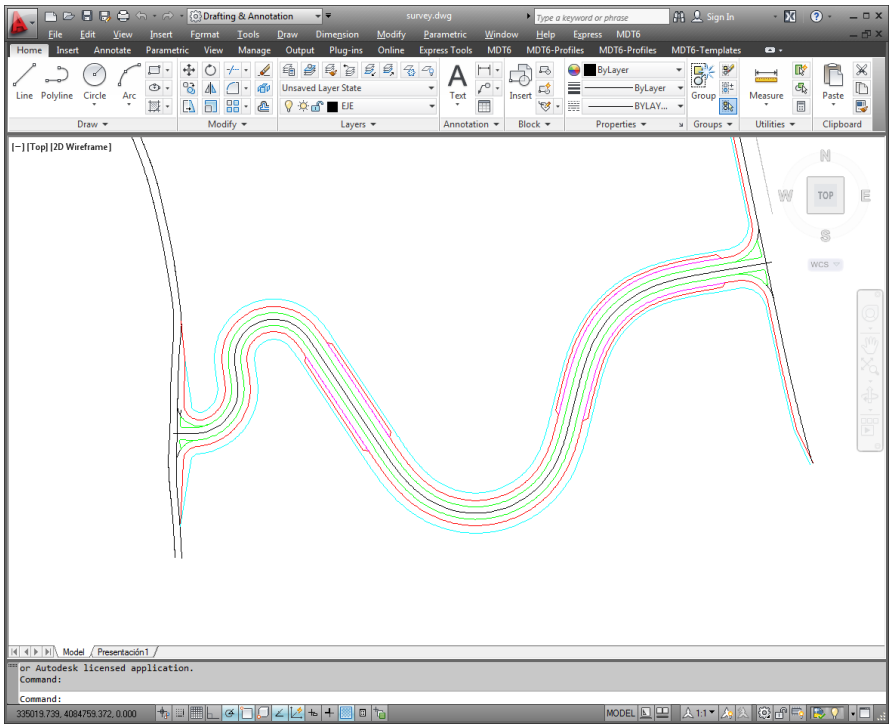
Tutorial 5. Templates from Drawing

In this chapter we start from a survey in which we have received the ground plan of the break lines that define the road. The purpose of this example is first assign properties to those polylines and secondly read the section drawing and build it automatically.

Once generated the templates, we will create the road segment or other files with the project and using the various commands we will see the final status of templates.

For the correct understanding of these processes should have previously run the examples 1, 2, 3 and 4 of this Manual.

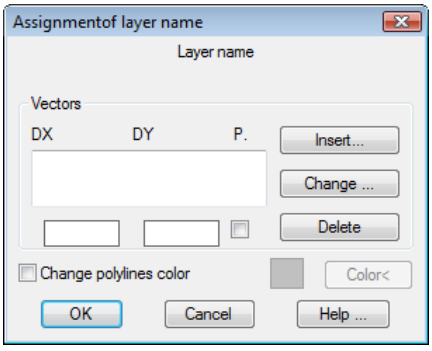
Open drawing `survey.dwg` from `C:\MDT6 Projects\Tutorial06` folder.



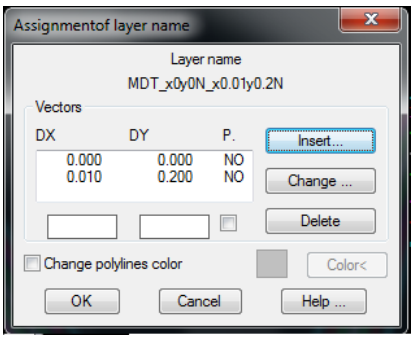
Initially we will assign the appropriate properties to the polylines. In our case, we have two polylines in the layer CURB, polylines that must match with two vectors in our template, corresponding to low and high curb.

We assign to these polylines two different behaviors. The line at the foot of the curb which have no variation with respect to the polyline preceding and corresponding to the height of the curb which has a difference of 20 cm with respect to low curb.

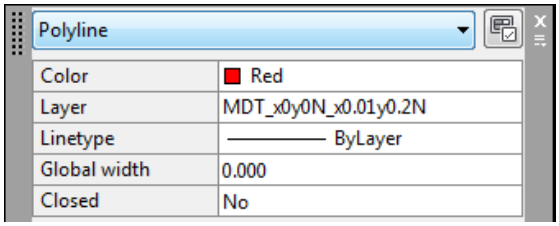
To accomplish this execute the command **Templates > Assign Properties to Vector Platform** (or in the ribbon **Templates > Creation> Prop. Vectors**) and select the two polylines found in the layer CURB in red color. Then a new window will appear to assign the properties:



We will now assign the properties as discussed above. To curb low impose no variation, so we enter **0** in both **DX** and **DY** edit boxes and press **Insert** button. For the high curb we assign **0.01** for **DX** and **0.20** for **DY**, pressing **Insert** again, leaving the definition as it appears in the following image:

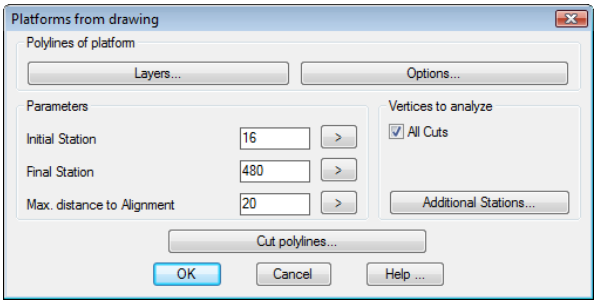


We can see how a new layer with special name has been created. The layer name will serve as reference for the automatic creation of the curb.

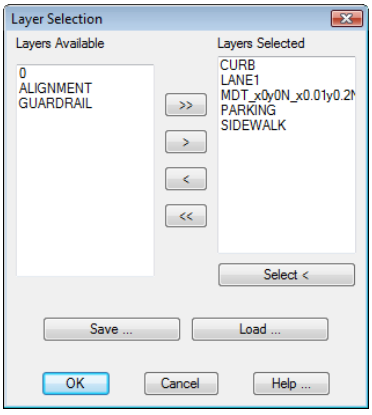


After the assignment of properties to different polylines, we create the templates automatically from the information in the drawing.

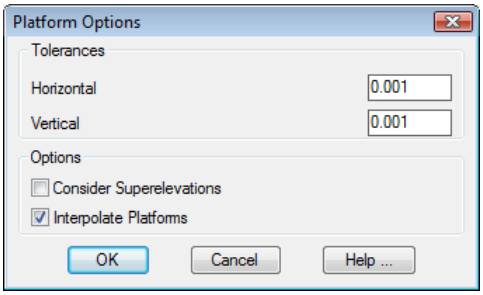
To do this, run the command **Templates > Convert Platform from Drawing** (or in the ribbon **Templates > Creation> Convert Drawing**) select a new file named `ROAD.SCC`. We also selected the alignment of the project, which can be designated on the screen or from file `ROAD.EJE` and then will appear the following window:



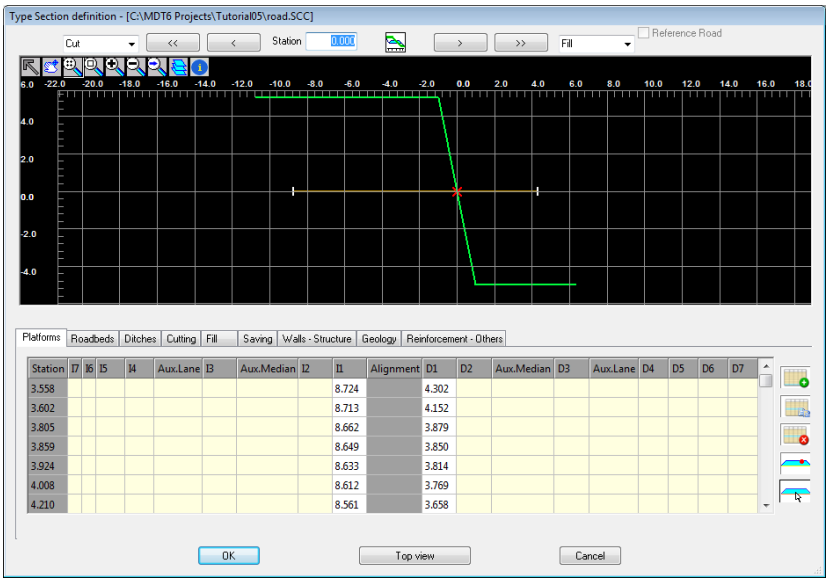
Modify the parameters as displayed in the image above. Press **Layers** button to select the layers which are polylines we want to have in mind for the generation of the template, as can be seen in the picture below.



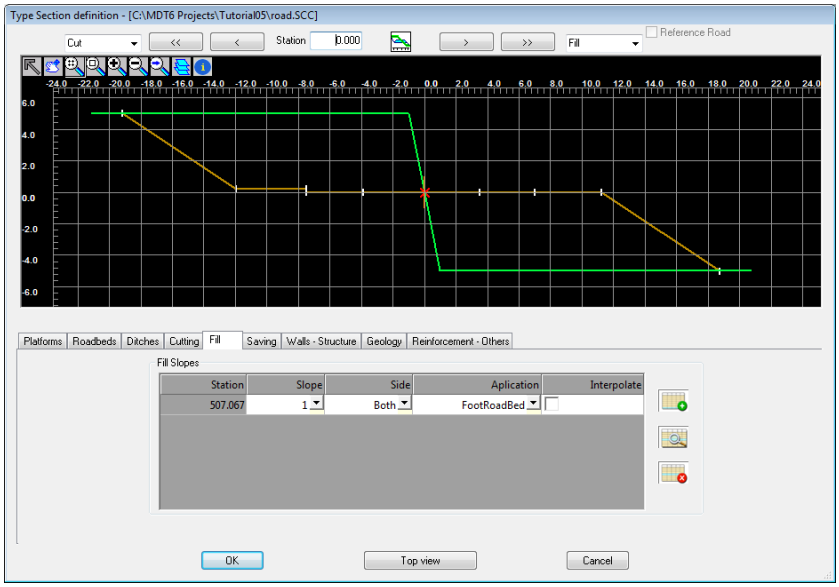
Then press **Options** button and enter as tolerances for both horizontal and vertical value 0.001.



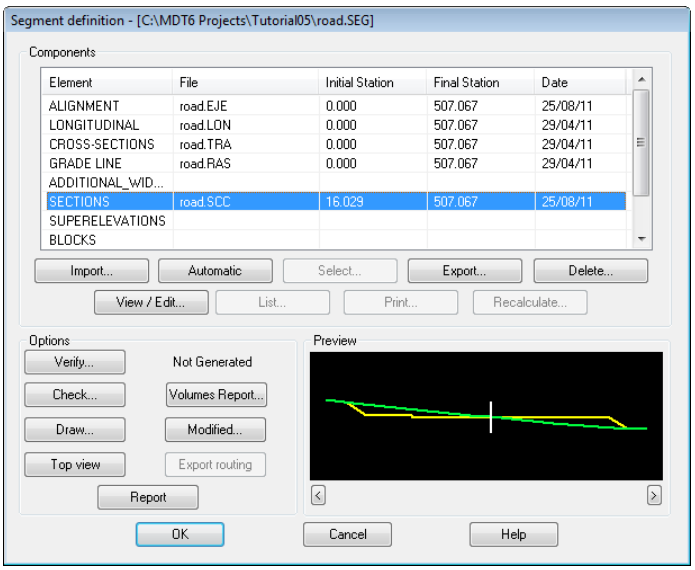
Finally, validate the windows and select all the visible entities in the drawing. It will automatically create the templates file with the information of all platforms. Run the command **Templates > Define / Edit** (or in the ribbon **Templates > Creation > Define / Edit**) and display the file templates created, where we already see the definition of the curb.



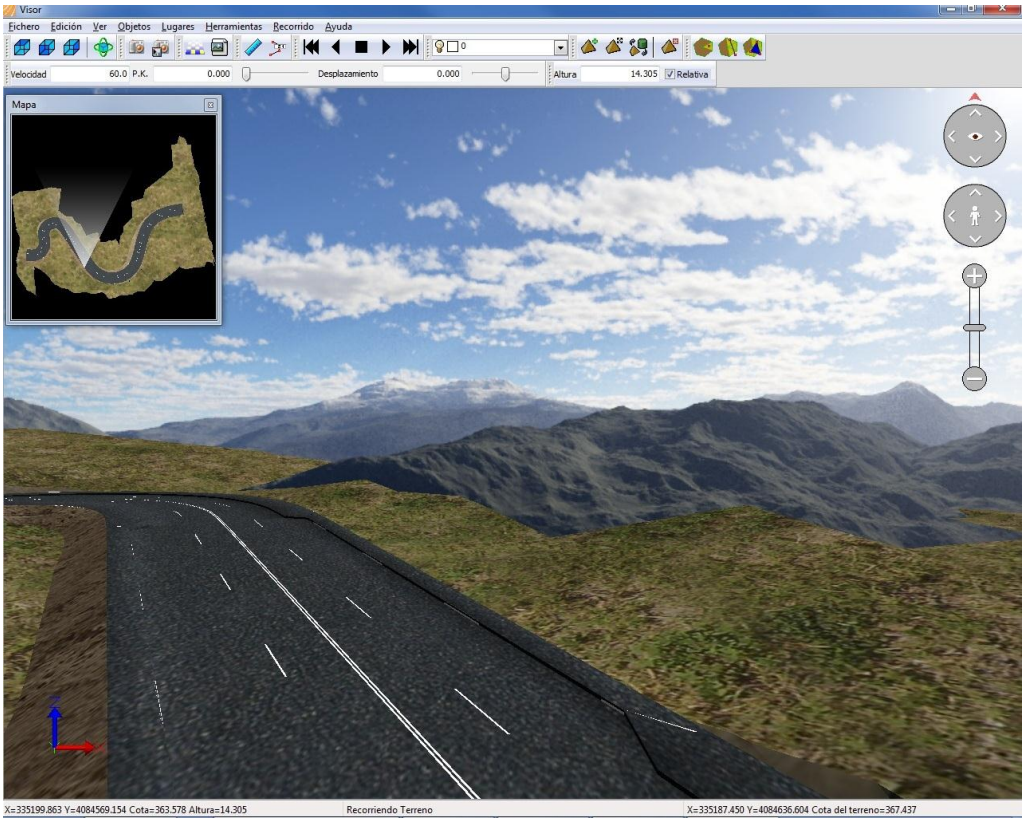
In this window, as was done in Example 4 we set the slope number **1** for both cut and fill to complete the definition of our template, leaving it as shown in the picture below.



Finally, we will create the segment of the road by running the command **Segments> Define / Edit** (or in the ribbon **Segments> Creation > Define / Edit**) and import the files found on the project folder, so the end result should be:



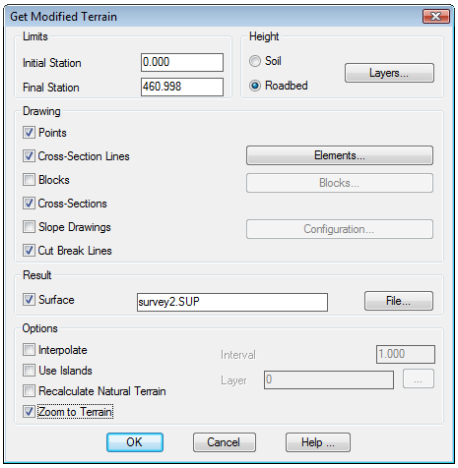
Once created the segment, with different commands we can view the final status of our road. For example run Maps / Render > Route by Road (or in the ribbon **Maps / Render > Viewer > Route by Road**).



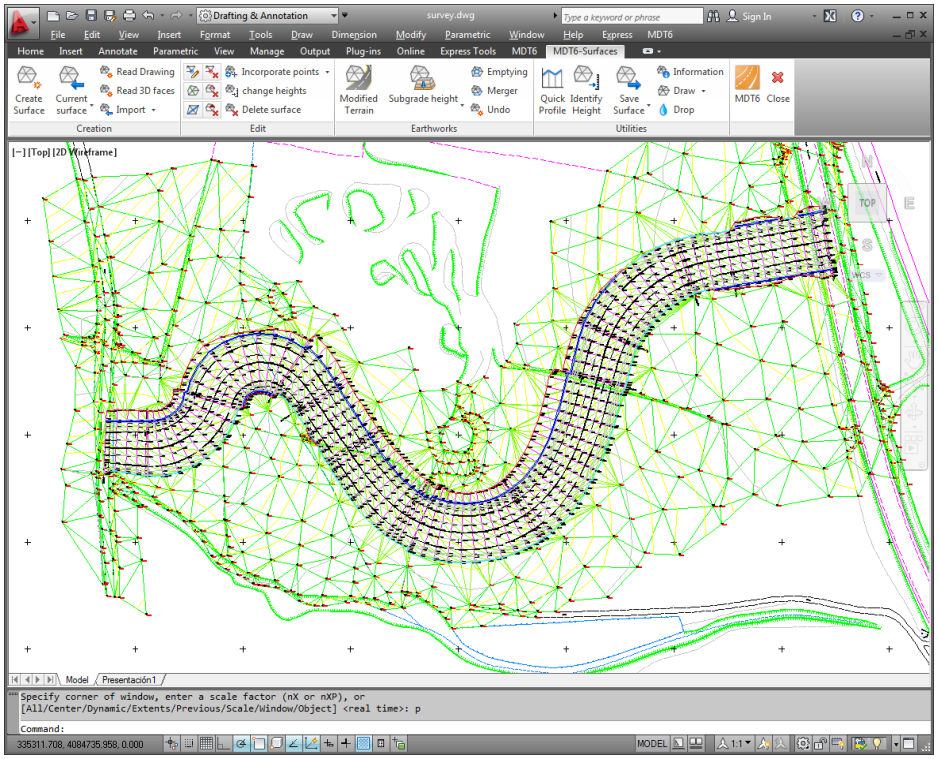
Tutorial 6. Obtaining Modified Terrain

Open the `survey.dwg` drawing in the `C:\MDT6 Projects\Tutorial06` folder.

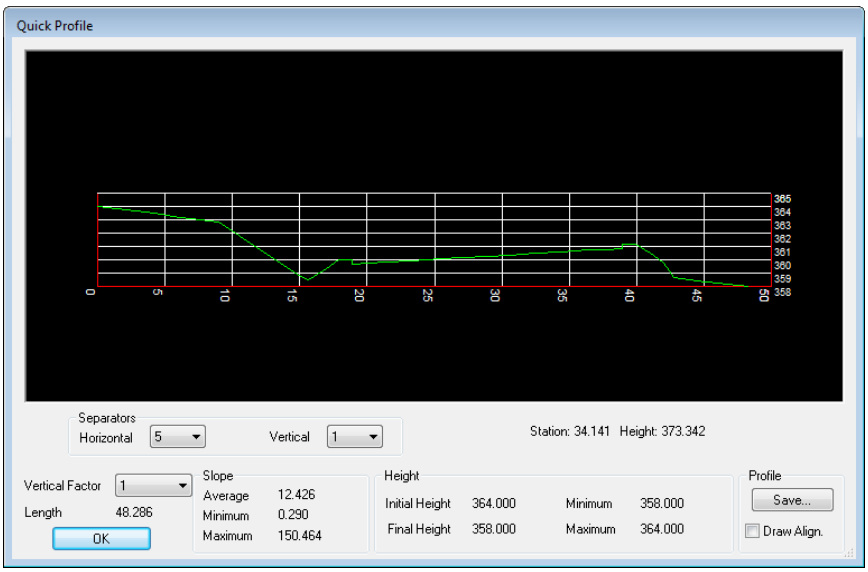
Now choose the **Surfaces > Get Modified Terrain** command (or in ribbon **Surfaces > Earthworks > Modified Terrain**), type ***F*** and select file `survey.SEG`. Activate the ***Surface*** option in the dialog box, so that the new surface will be saved in the `survey2.SUP` file, leaving the original surface unchanged. Leave the rest of the check boxes as the appear in the figure below.



Lastly, click on ***OK***. Once the calculation process has finalized, the result will be the following:

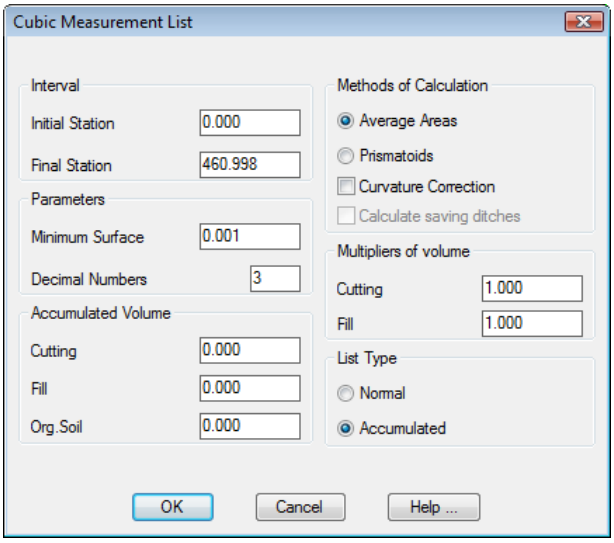


The original terrain is automatically modified to show the new road and the new surface. If we use the **Quich Profile** option, we can view the modifications for the original model.

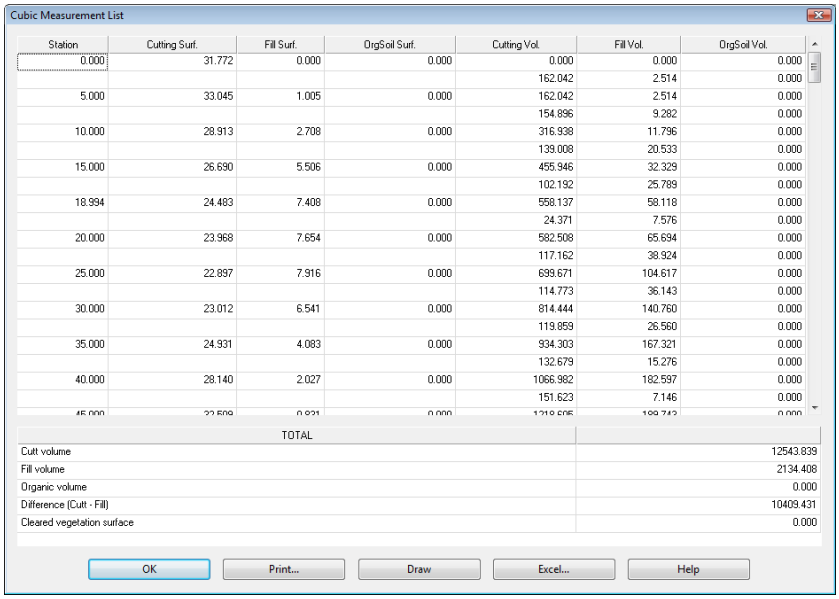


List of Cubic Measurements

Next, we will produce a capacity list for the road. Use the **Volumes > Cubic Measurement List** (or in ribbon **Volumes > Sections > Cubic Measurement List**), select `survey.SEG` file command and press ***OK***.



Then you will see a report with the calculation of the areas in elevation of each cross section with their corresponding volumes.

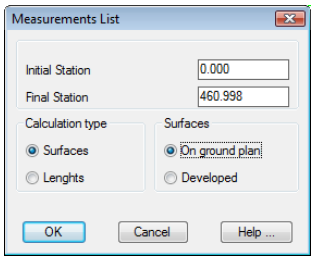


Volumes List

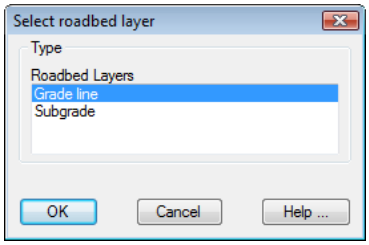
Next we will obtain a surface and volume list which will allow us to perform the earthwork calculations.

Use the **Volumes > Cross Sections Measurements Report** command (or in ribbon **Volumes > Templates > Surfaces > List of Cross Sections Measurements**), select the `survey.SEG` file.

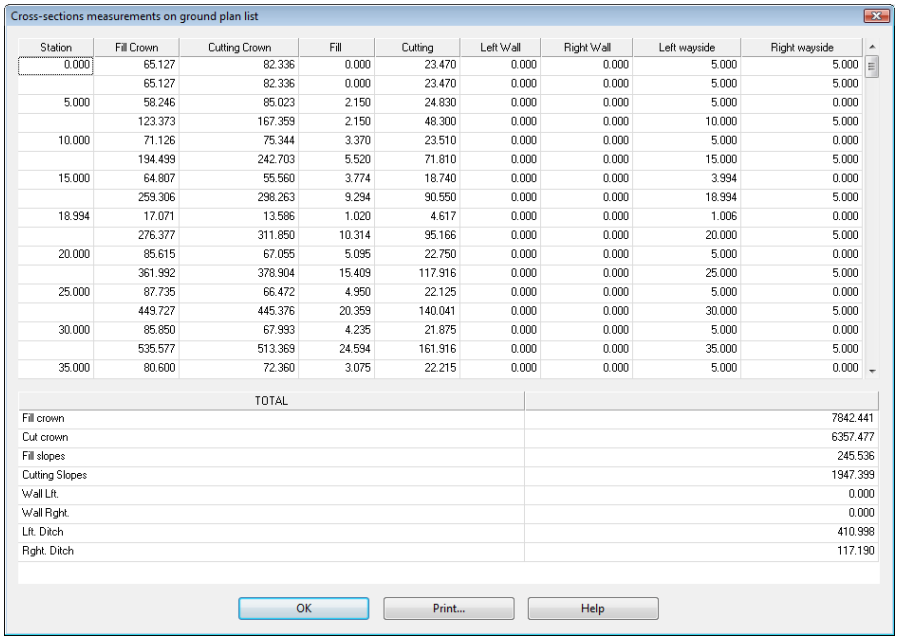
The calculation we want to make is areas measured **On ground plan**, by selecting this option and confirming the dialog.



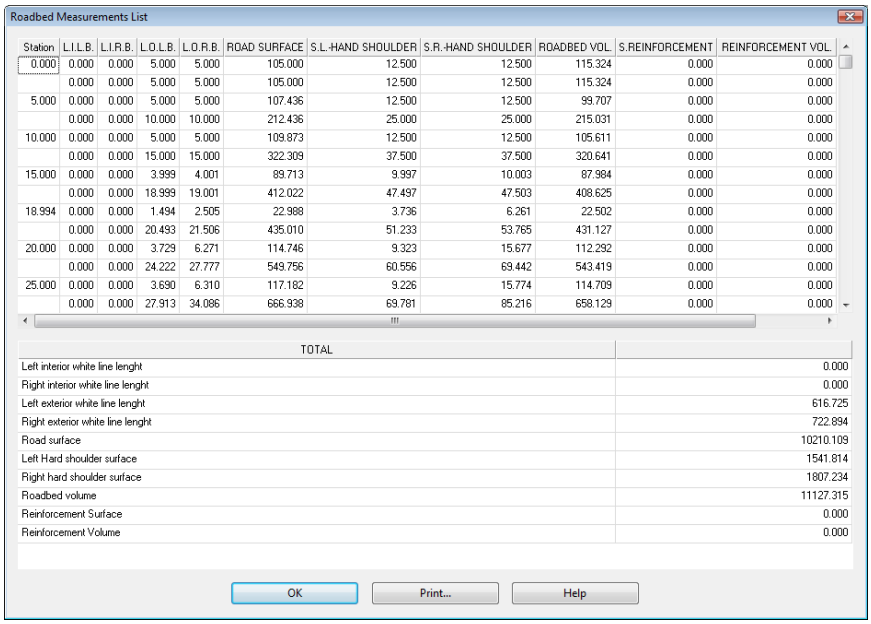
Then, if a roadbed has been defined in our road we will see a window where we select the layer on which we want to make the measurement. In this case only the grade and subgrade appear because we have not set any roadbed middle layer. Select **Grade line** layer and press **OK**.



There will now appear a list of the crowning surfaces and road slopes, station by station.



A list of roadbed measurements will now be obtained, that is to say: road areas, lengths, etc. In order to do so, click the **Volumes > Roadbed Measurements Report** command (or in ribbon **Volumes > Sections > Roadbeds > Roadbed Measurements Report**). Select file `survey.SEG` and validate the dialog.

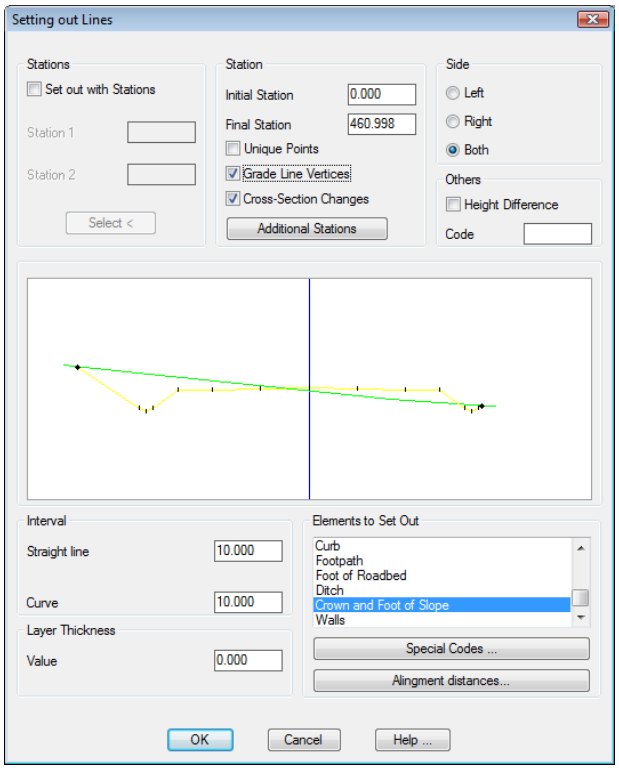


In this list the roadbed volume and the reinforcing data is null, since we have not yet defined them in our template.

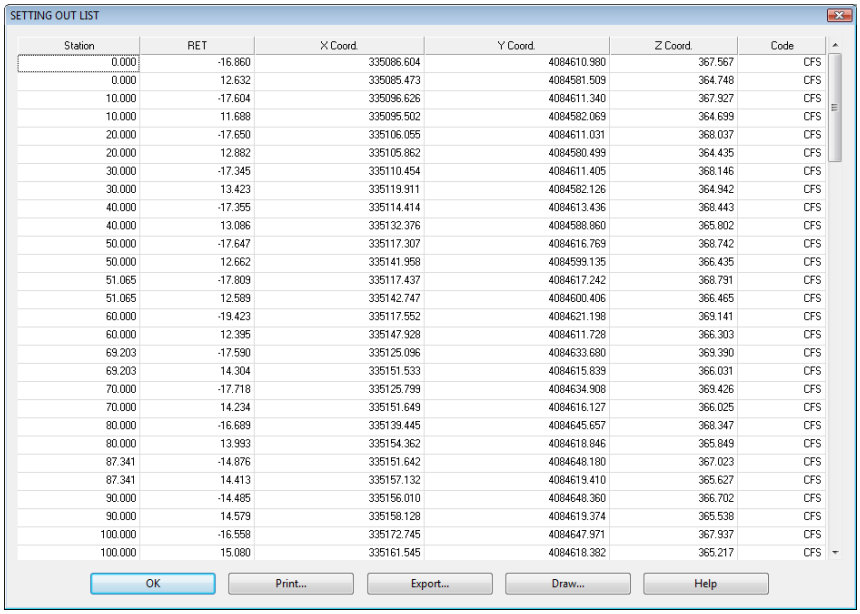
Setting Out

Vamos a realizar un replanteo de puntos característicos del vial. Para ello ejecutar el comando **Replanteo > Replanteo de Líneas** (o bien en la cinta de opciones **Replanteo > Segmento > Replanteo Líneas**), seleccionar el fichero `TOPOGRAFICO.SEG`, seleccionamos **Rasante** como capa a analizar y en el diálogo activar en el listado de elementos a representar la línea ***Cabeza y Pie de Talud***. Pulsar **Aceptar.**

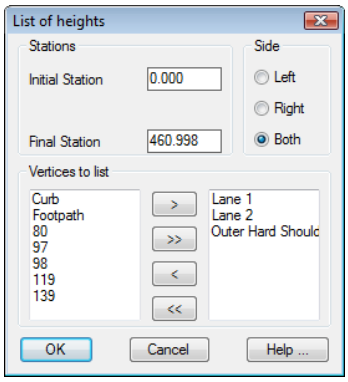
Let's set out main points that define the road. To do this execute the command **Setting Out > Setting Our Lines** (or in ribbon **Setting Out > Segment > Setting Out Lines**) select the file `survey.seg`, select **Grade line** as a layer and press **OK**. Now select **Crown and Foot of Slope** and set other options as shown in the figure and press **OK**.



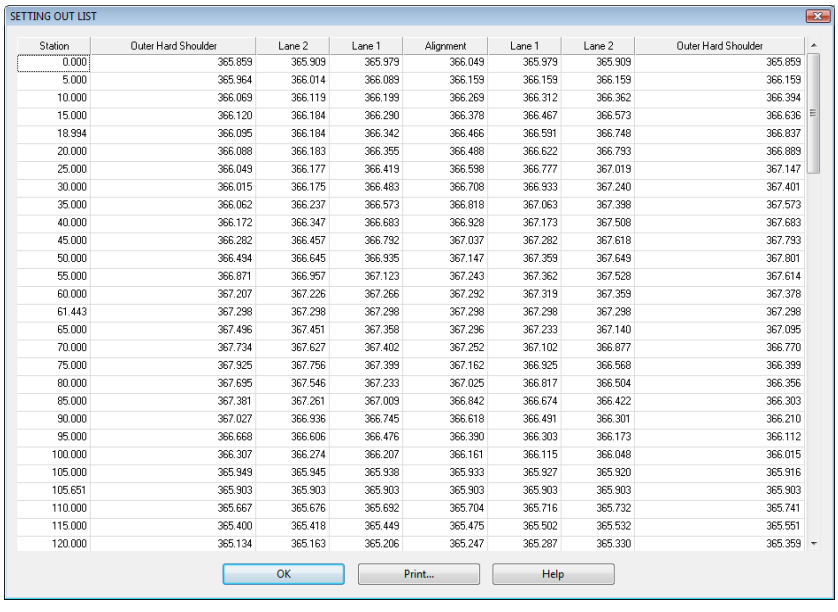
Then a report will appear showing the coordinates and other characteristics of each stake point.



Then we will perform an analysis of template heights, by running the command **Stakeout > List of Heights** (or in the ribbon **Setting Out > Segment > List of Heights**). Select the file `survey.seg` and then indicate that we will work on **Grade line** as in the previous cases. The following window will appear where you state vector which we wish to analyze the dimensions and configure the data to be analyzed by the image below, by clicking the icon > to select the vertices starting with.

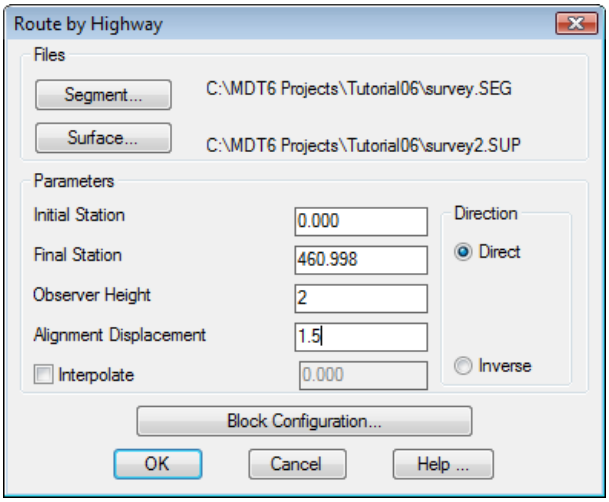


Once established the vertices to stakeout, after validated the window a height report will appear.



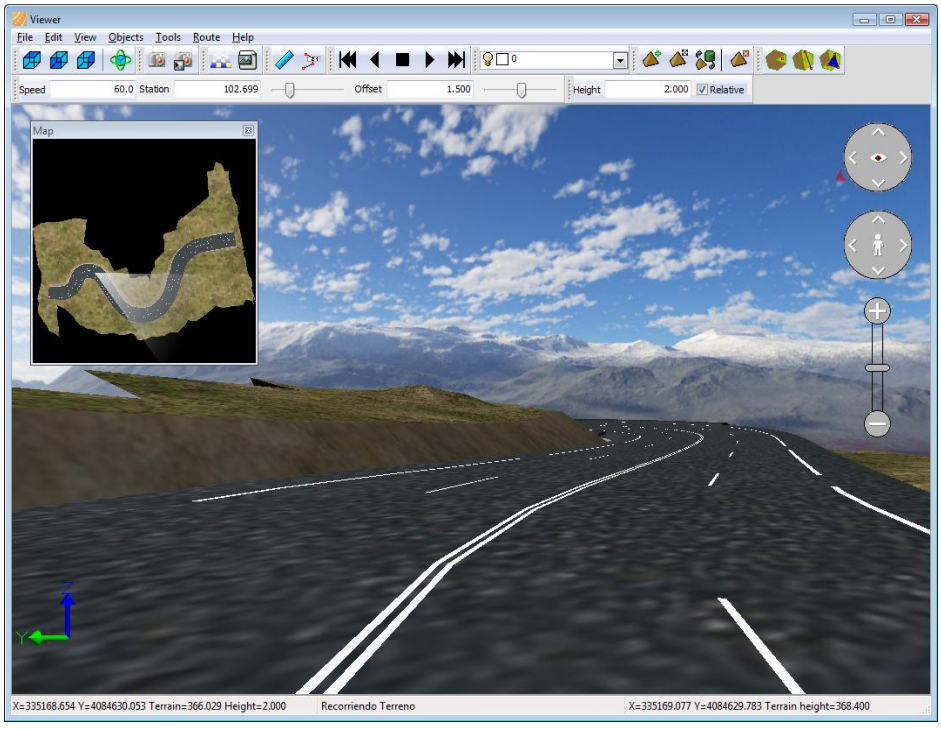
Road Tour Simulation

Execute the **Maps/Render > Route by Highway** command (or in ribbon **Maps/Render > Route by Highway**), click the **Segment** button and select the `survey.SEG` file. Then click the **Surface** button and select the `survey2.SUP` file.



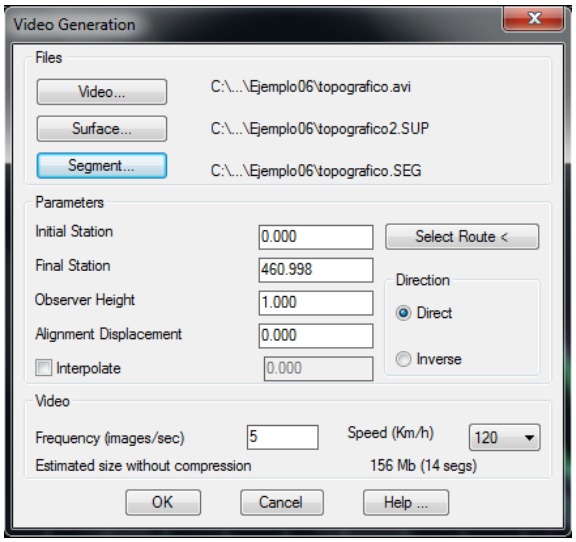
Also enter the value of **2** in the **Observer Height** box and **1.5** in the **Horizontal Alignment Adjustmen** box. Click on **OK**. A window will be displayed showing a realistic simulation of the highway.

Experiment with the dialog box's command, going forward and back along the alignment, changing speed, station and observer height, among others. Finalize the process by closing the window or pressing **ESC**.



Video Generation

In order to generate a video of the route simulation, execute the **Maps/Render > Generate Video** command (or in ribbon **Maps/Render > Viewer > Generate Video**). If the program requests you to select a type of video compression, select the Complete Frames (without compression) option Select `survey.AVI` as the name of the video to be generated, the same files as in the previous steps as the surface and segments. Then click ***OK***.



One only has to double click on the video file from the Windows explorer to view the result in the system's default viewer.

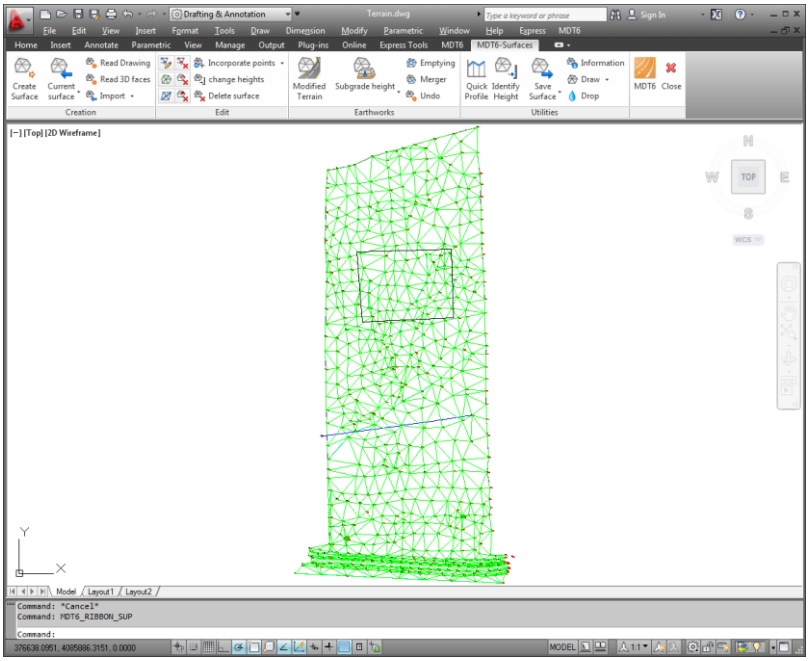
Tutorial 7. Explanade Creation

This case describes how to effect earthworks or excavations from a pre-defined digital model. Using the new model and the original, a volume calculation by grids, along with a 3D representation and an assigned materials rendering.

Explanade Drawing

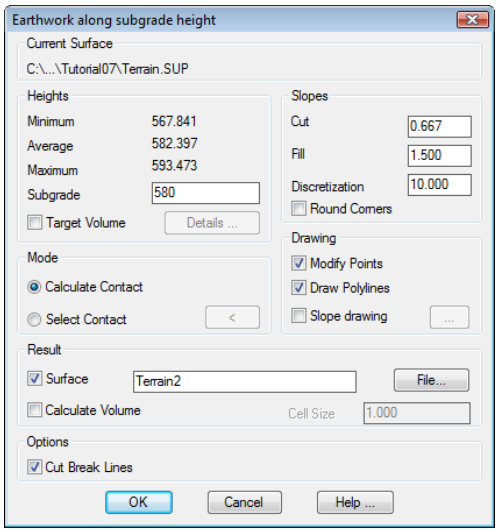
Open the drawing `Terrain.dwg`, in the `C:\MDT6 Projects\Tutorial07` folder.

In the drawing we are going to insert a block containing the levelling to be carried out. Use the AutoCAD **Insert > Block** command, press the **Browse** button and select the drawing `Explanade1.dwg` from the same folder. Insert this at coordinates 0,0, with a scale of 1, rotation angle of 0 and the **Explode** option enabled. The block can also be expanded once inserted.



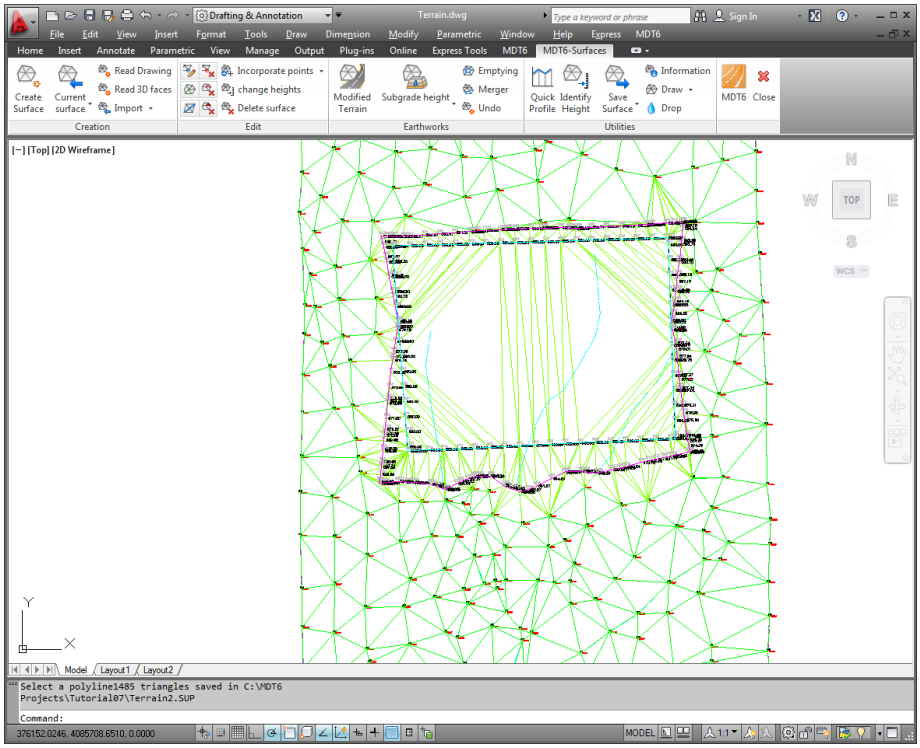
Earthworks by Explanade Elevation

Use the **Surfaces > Earthworks > by Subgrade Height** command (or in ribbon **Surfaces > Earthworks > Subgrade height**) and select the drawing's polyline. The following dialog box appears, used for the configuration of the earthworks about to be realised.

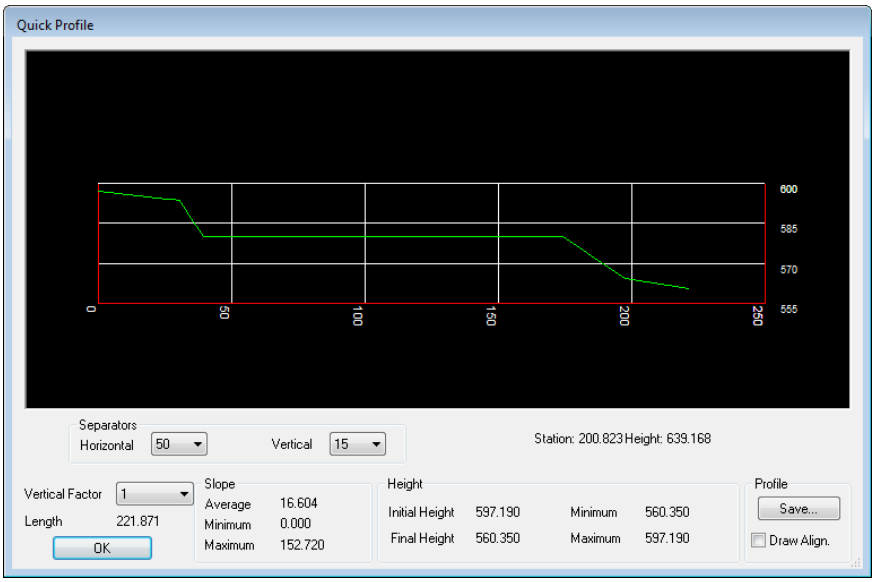


Enter the height of **580** in the **Subgrade** box and activate the options appearing in the figure above. As cut and fill slopes, keep the default values. Click ***OK***.

The program will automatically create a new surface called **Terrain2**, which will be drawn with its contacts.



To see the changes to the model, use the **Quick Profile** command from North to South. Notice how the completed task is highlighted.

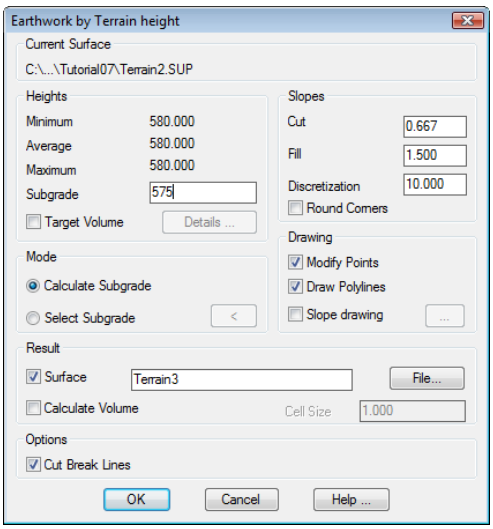


Earthworks by Terrain Elevation

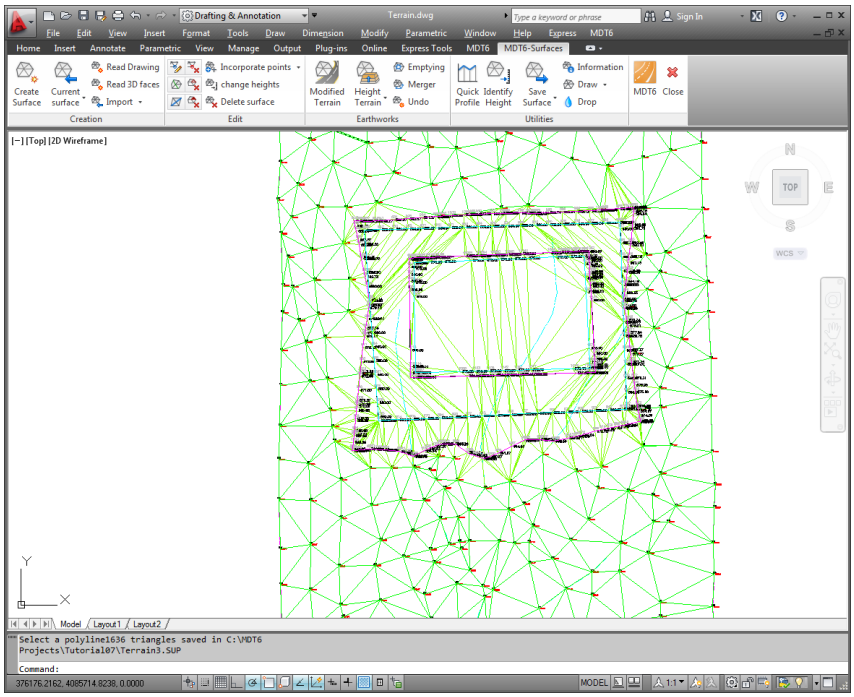
Using the actual surface as a station, we will perform an earthwork of which we know the contacts with the terrain in the site of the levelled surface boundary.

Activate layer 0 and insert the `Explanade2.dwg` file as before.

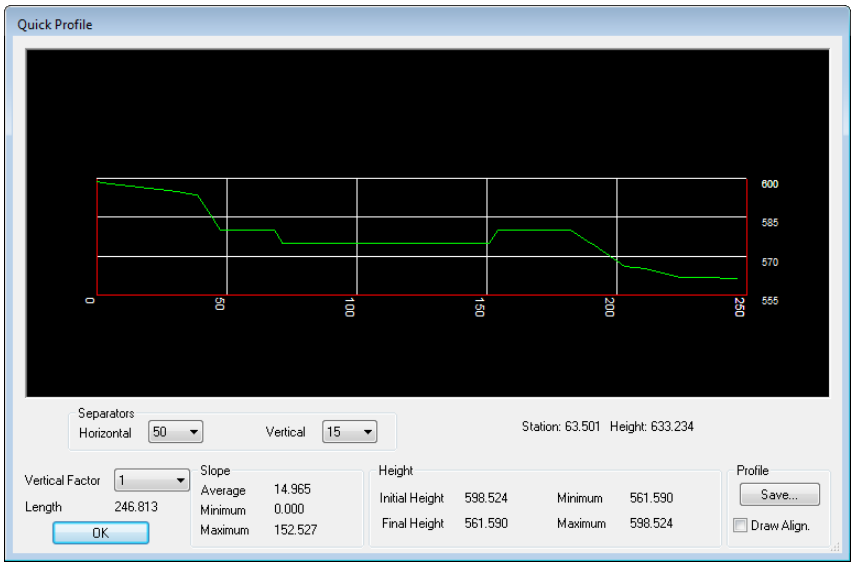
Choose the **Surfaces > Earthworks by Terrain Height** command (or in ribbon **Surfaces > Earthworks > Height Terrain**) and designate the new polyline. The following dialogue box appears, specifying the surface characteristics to be calculated.



In explanade height type **575** and keep the rest of the default values. Validate the dialogue box.

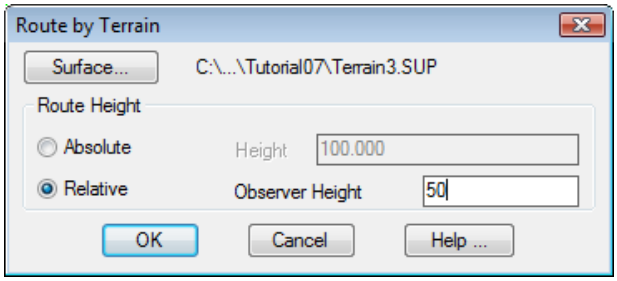


In the same way as before, using the **Quick Profile** command, we can view the actual model.

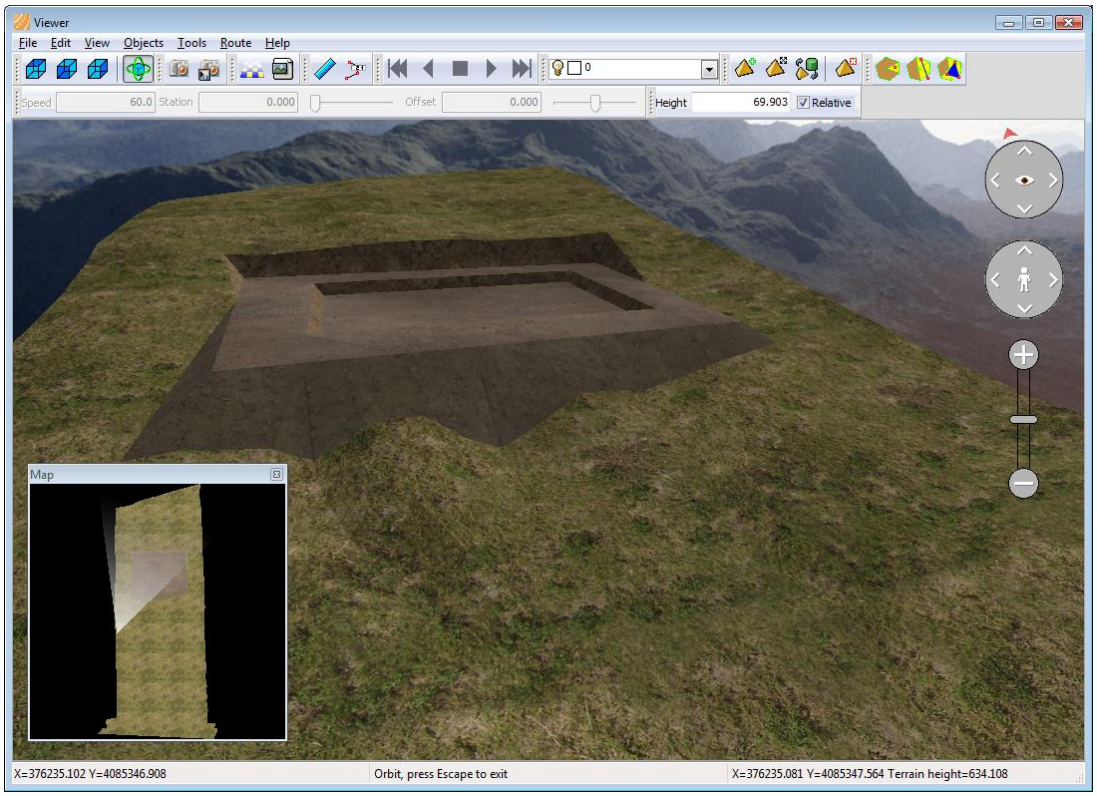


Route Terrain Simulation

A virtual tour through the terrain will now be put together. In order to do so, execute the **Maps/Render > Route by Terrain** (or in ribbon **Maps/Render > Viewer > Route by Terrain**, select the `Terrain3.SUP` surface and specify **50** as **Relative Observer Height.**



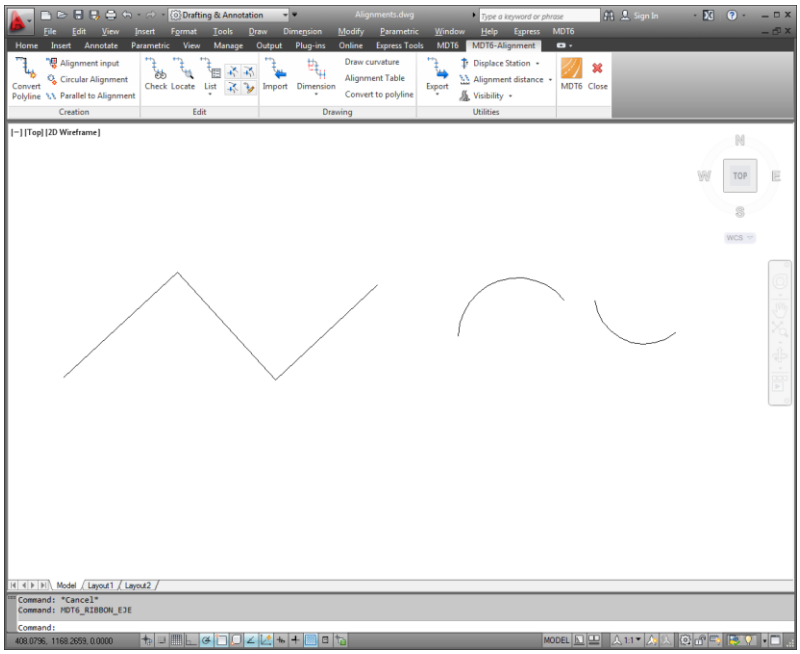
Click ***OK*** and the terrain viewer will be inialised. Experiment with the controls to change the image.


Viewer
File Edit View Objects Tools Route Help
Speed 60.0 Station 0.000 Offset 0.000 Height 69.903 Relative
Map
X=376235.102 Y=4085346.908
Orbit, press Escape to exit
X=376235.081 Y=4085347.564 Terrain height=634.108

Tutorial 8. Alignments

In this example we will describe the fundamental element design tools. For this we will fit together several tracing elements, using different techniques, and then we will convert them to an horizontal alignment to be used for profile calculation and setting out.

First open the `Alignments.dwg` file in the `C:\MDT6 Projects\Tutorial08` folder.

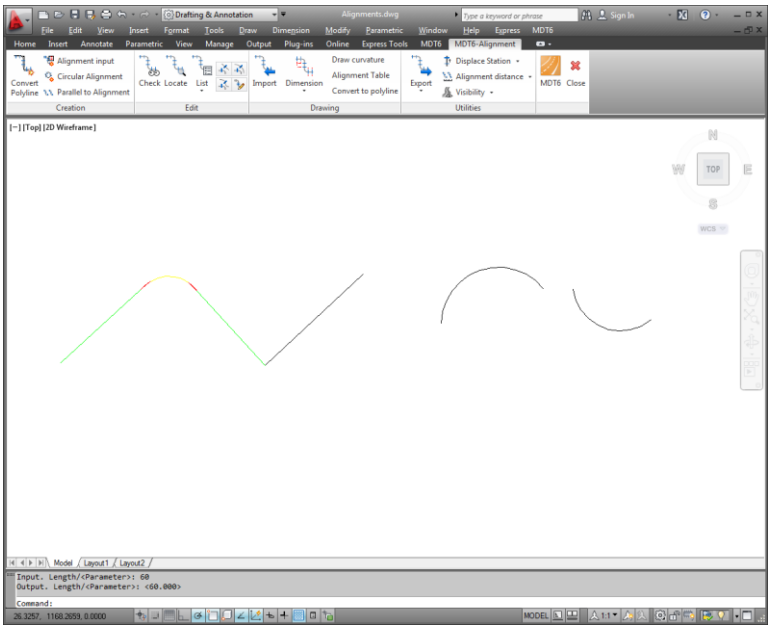


Element Fitting

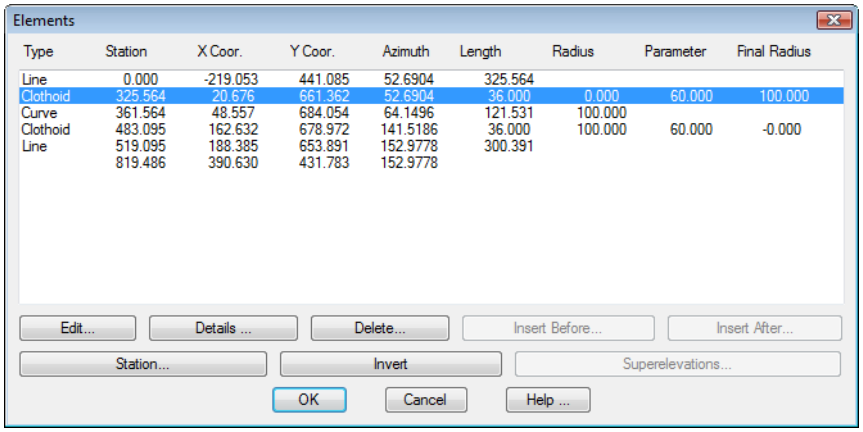
Insert a clothoid-curve-clothoid transition between the two lines on the left. Use the **Elements** > **Clothoids** > **Clothoid-curve-clothoid between Lines** command. Select the first lines in the left whichever order and type in the following parameters:

```
Radius: 100
Input Length/<Parameter>: 60
Exit. Length/<Parameter>: <60.000>
```

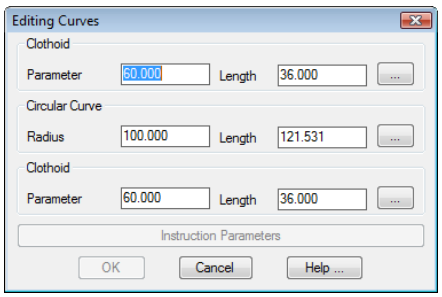
Notice that the original lines are now drawn in green, and the new clothoids are drawn in red. The circular curve is drawn in yellow.



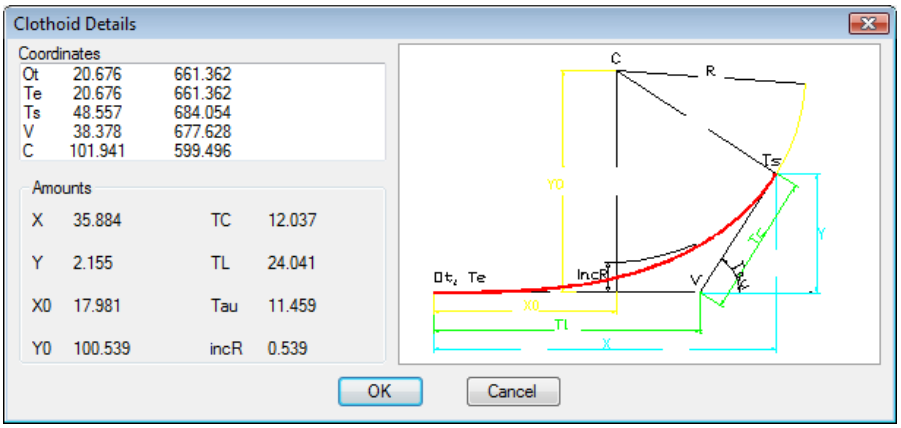
To check the analytical and geometric information obtained from each of the newly created elements, use the **Elements > Edit** command and select the left-most clothoid in red color. The following dialogue box appears:



Now press the **Edit** button to show the editable parameters.



Observe that only the parameter and clothoid length can be edited for linked road design elements as they are within in a group. Click **Cancel** and then the **Details** button**.** The following dialogue box appears:

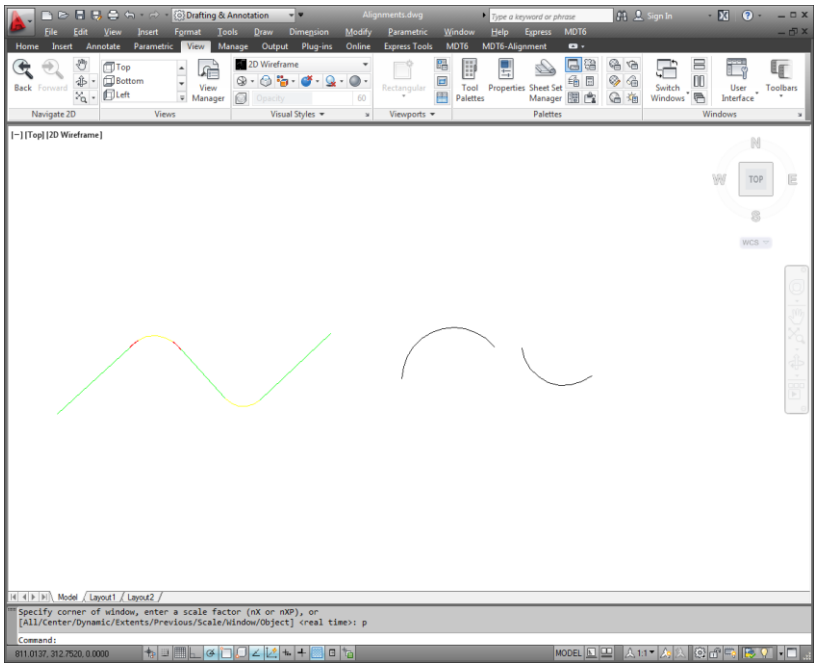


Try the same with the recently created clothoids and straights. Accept all the open dialog boxes.

Now a curve situated more to the right will be inserted between two straights. Use the **Elements > Curves > Curve tangent to two lines or curves** command. Select the last two lines and at the prompt

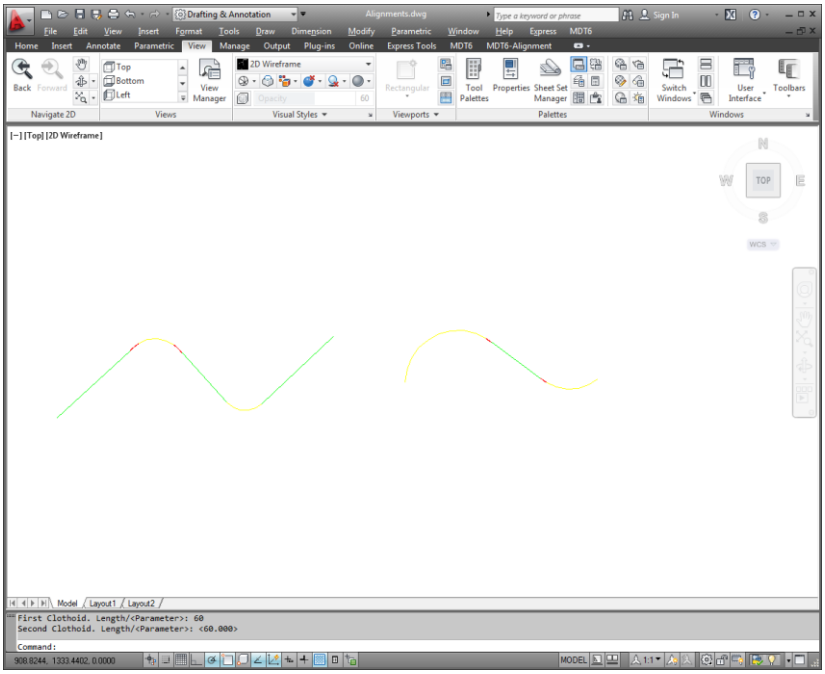
```
Curve according to Length/Chord/Tangent/Arrow/Through Point/<Radius>:
```

insert the value **80** as radius (default value). A new yellow curve will be drawn between the two lines.



Next, insert a clothoid-straight-clothoid transition between the two arcs to the right of the drawing. Use the **Elements > Clothoids > Clothoid-line-clothoid between curves** command. Select the two curves and enter **60** as the clothoid entry and exit values.

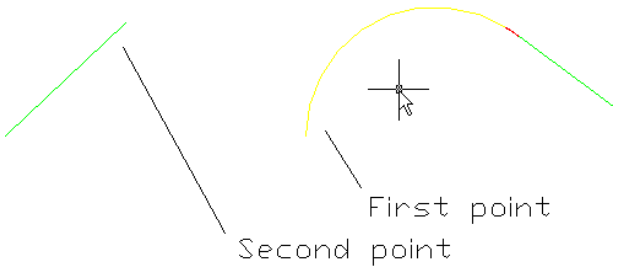
```
First Clothoid. Length/<Parameter>: 60
Second Clothoid. Length/<Parameter>: <60.000>
```



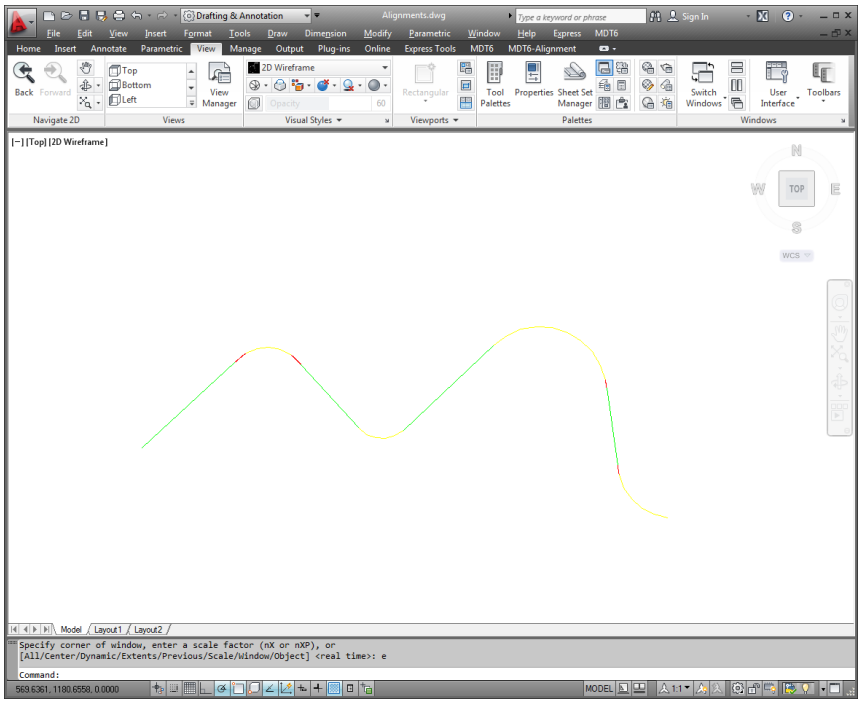
Element Connection

Now we can connect all the drawn elements.

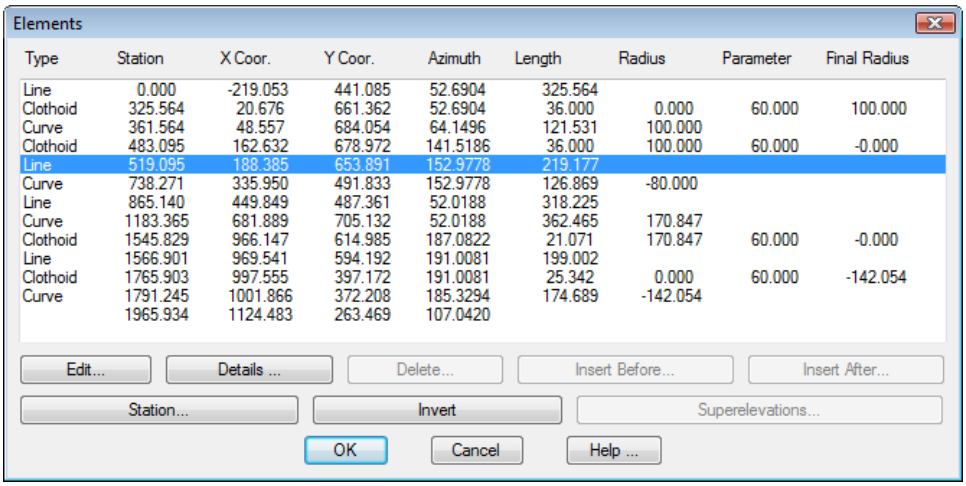
First, we will connect the group of elements on the right with the group on the left. Use the **Elements>Connect Elements** command, choose the left hand extreme of the right hand group and then the right hand extreme of the left hand group (see figure).



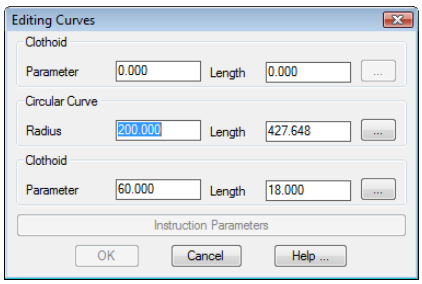
Now we can join them in one single group. Use the **Elements > Group Elements** command and select all the elements. One then indicates the left-hand end as the origin and assigns the value of **0** to the initial station. The program informs one that 12 elements have been grouped with a total length of 1965.934.



To check the result, use the **Elements > Edit** command and select any element. The following dialogue box appears:

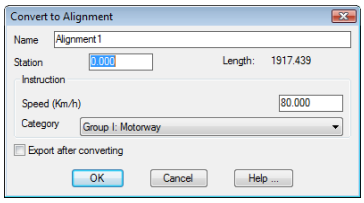


Double click on station 1183.365. The curve alignment characteristics are shown. Change the radius value to **200**. Press ***OK*** and then again ***OK***. Notice how the drawing has been modified.



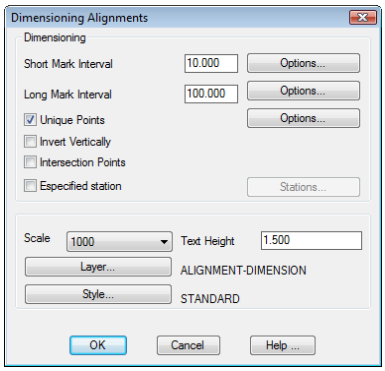
Conversion to Alignment

Lastly we will convert the elements previously created to an alignment to be used by the other system commands. Use the **Elements > Convert to Alignment** command and select the alignment at any point. The following dialogue box appears:

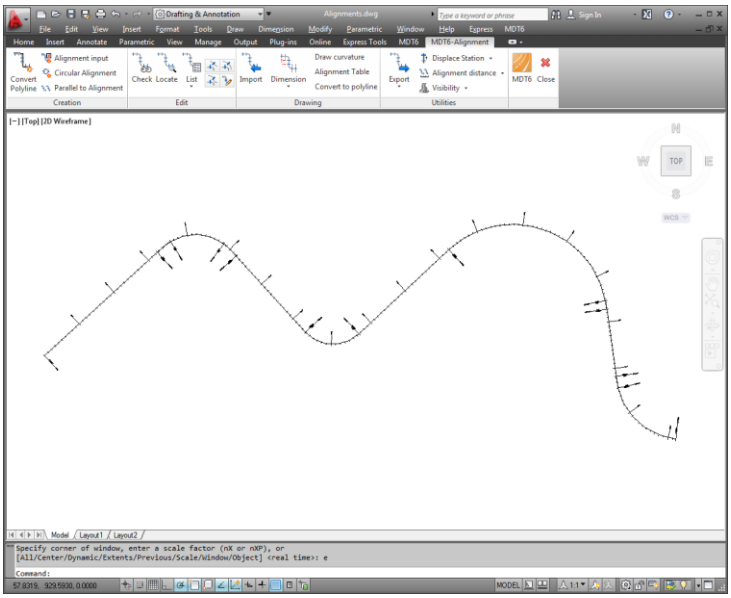


Accept the proposed parameters and press **OK**. A polyline will be created in the alignment layer, deleting the previous alignments. These can be recovered using the **Alignments > Ungroup Elements** command.

The last step is to dimension the alignment. Use the **Alignments > Dimension Alignment** command (or in ribbon **Alignments > Drawing > Dimension)** and select the last polyline created. The following dialog box is displayed:



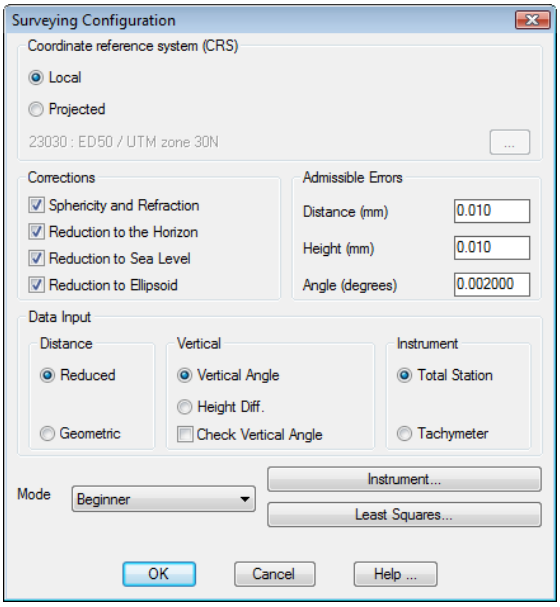
Press **OK**. The dimensions are automatically drawn on each of the elements. Use the REGEN command if neccesary to improve the curve's quality of representation.



Tutorial 9. Survey Calculations

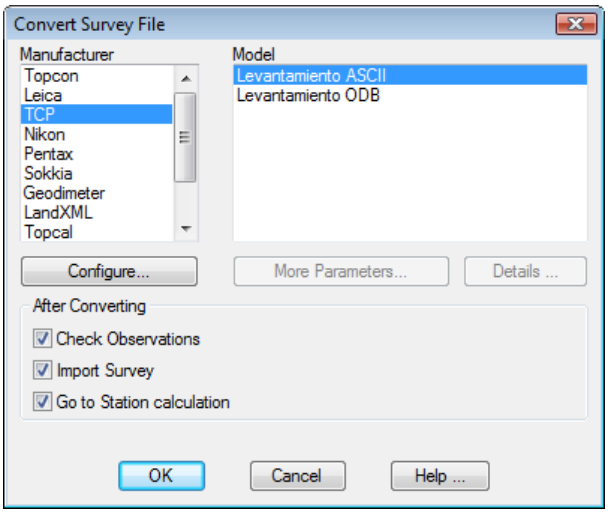
The aim of this example is to convert a file produced in the field, calculate the point and station coordinates, compensate a traverse and transform the coordinates.

First, edit the configuration using the **Utilities > Setup** command, press **Surveying** and in the **Mode** field choose **Beginner**. Accept the changes.

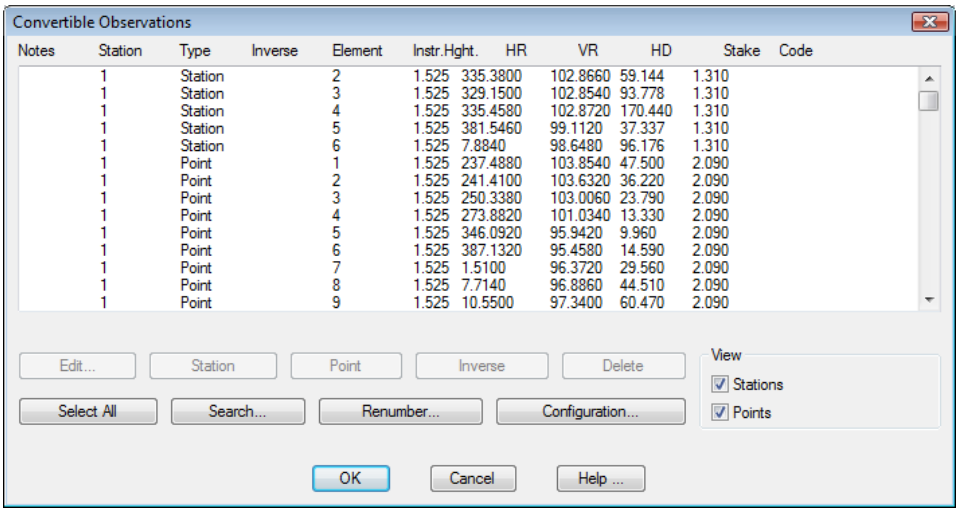


Data Collector File Conversion

The first step is to convert the file from the total station or the data collector used for the survey. Para ello elegimos **Surveying and Geodesy > Surveys > Import**. Select as the manufacturer **TCP**, specify the format as **Levantamiento ASCII** and choose the `network.LEA`, file in the `C:\MDT6 Projects\Tutorial09` folder. Activate the three boxes in the **After Converting** frame.

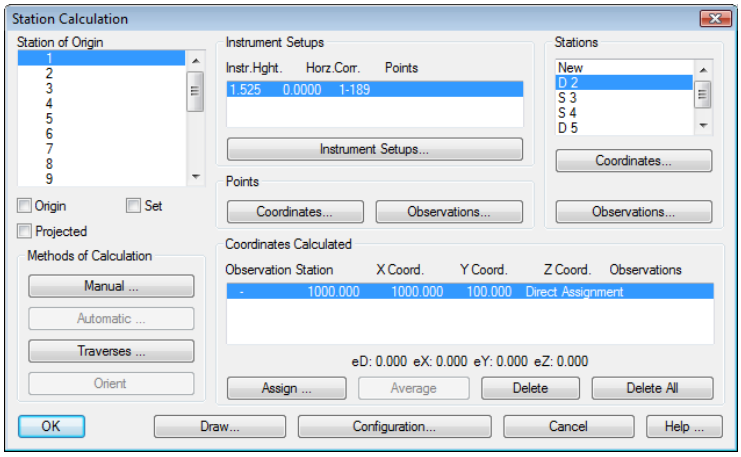


Accept the proposed file name for destination. The following dialogue box allows the revision of the imported observations, deleting the erroneous ones, deciding upon whether to interpret them as point observations or station observations (in the case of incorrect interpretation) and to process repeated observations. In this example we press **OK** without making any changes.

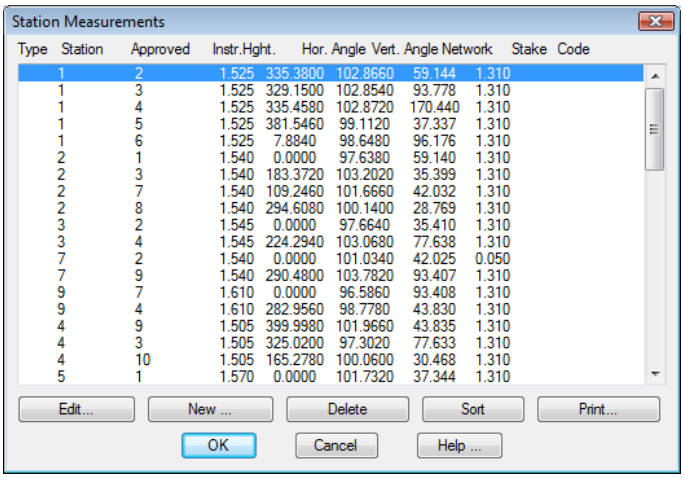


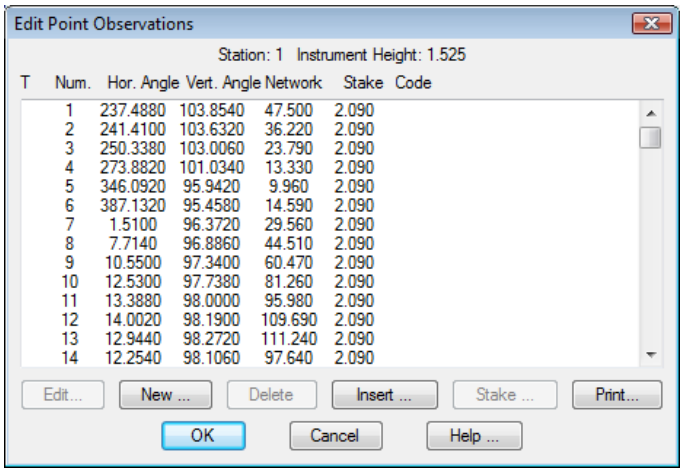
Coordinate Calculation

We can now proceed to calculate the station and point coordinates. The list in the top left-hand side of the screen (**Origin Station**) corresponds to the stations where we positioned ourselves in the field. Scanning this list shows how the program informs us of the stations visited since the selected ones (**Target Stations**), the instrument heights and the point read from it (**Instrument Setup**). For example, from station 1, stations 2.5 and 6 were read in double mode, i.e., there and back, and 3 and 4 were read in simple mode, i.e., one way only. Select other stations to see how the information changes.

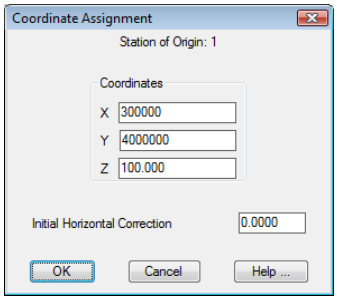


We can edit or view the station and point Observations easily. Use the **Observations** button in the **Target Stations** frame and a complete observations list is shown. Double clicking on any of them or pressing the **Edit** button allows viewing or modification to any field. For point observations, use the **Observations** button in the **Points** frame.

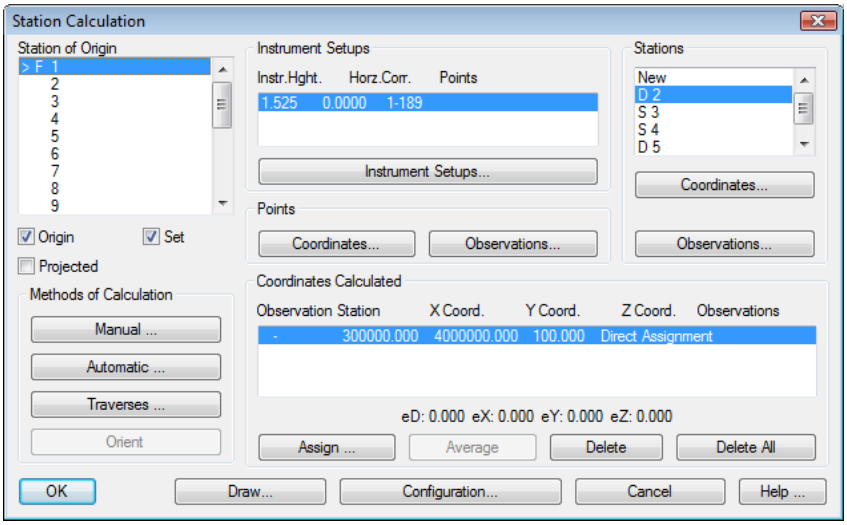




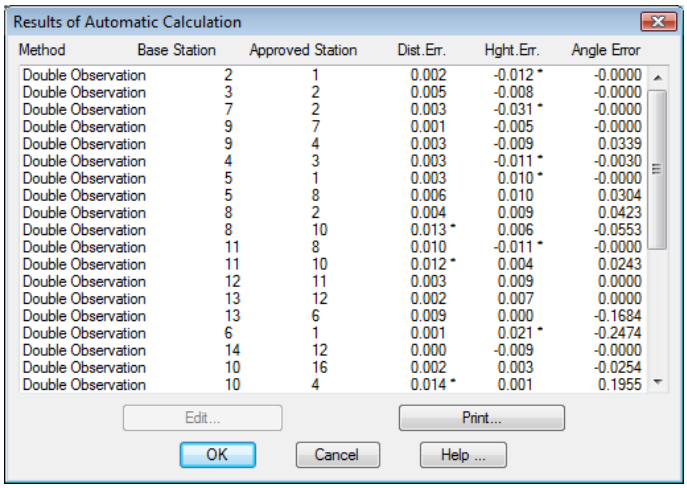
The next step is to assign some coordinates, starting from the origin station (in this case number 1). Select this station and press **Assign**. Type x=**300000**, Y=**4000000**, Z=**100** and validate, observing that **Fixed** check box in the Station Calculation dialogue box is now active and that the coordinates also appear in the **Calculated Coordinates** frame.



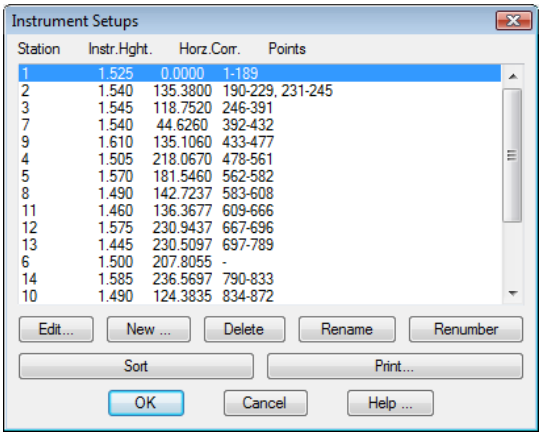
Now we proceed to automatically calculate all the stations and points, following the sequence of the original field file. First we tell the program, which is the station of origin, selecting **1** and we activate the **Origin** box. Observe that the **Automatic** button is highlighted.



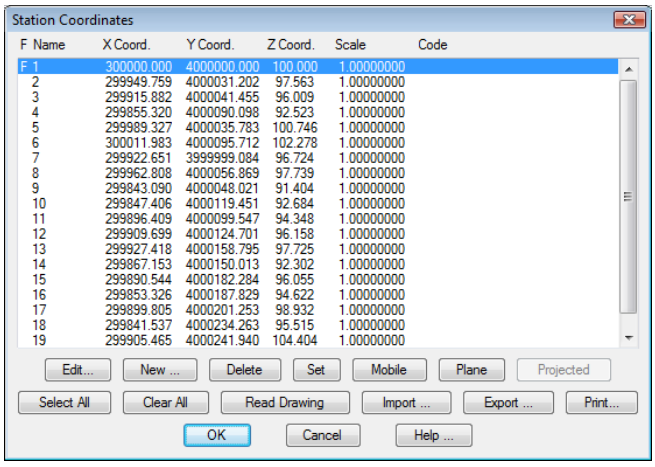
Press the **Automatic** button to show a results report in which are shown the calculated stations, the method used and any errors in distance, height or angle. Asterisks indicate that the pre-set limits have been exceeded. Pressing **OK** assigns all of the coordinates to their corresponding stations and points.


Results of Automatic Calculation
Method Base Station Approved Station Dist.Err. Hght.Err. Angle Error
Double Observation 2 1 0.002 -0.012 * -0.0000
Double Observation 3 2 0.005 -0.008 -0.0000
Double Observation 7 2 0.003 -0.031 * -0.0000
Double Observation 9 7 0.001 -0.005 -0.0000
Double Observation 9 4 0.003 -0.009 0.0339
Double Observation 4 3 0.003 -0.011 * -0.0030
Double Observation 5 1 0.003 0.010 * -0.0000
Double Observation 5 8 0.006 0.010 0.0304
Double Observation 8 2 0.004 0.009 0.0423
Double Observation 8 10 0.013 * 0.006 -0.0553
Double Observation 11 8 0.010 -0.011 * -0.0000
Double Observation 11 10 0.012 * 0.004 0.0243
Double Observation 12 11 0.003 0.009 0.0000
Double Observation 13 12 0.002 0.007 0.0000
Double Observation 13 6 0.009 0.000 -0.1684
Double Observation 6 1 0.001 0.021 * -0.2474
Double Observation 14 12 0.000 -0.009 -0.0000
Double Observation 10 16 0.002 0.003 -0.0254
Double Observation 10 4 0.014 * 0.001 0.1955
Edit...
Print...
OK
Cancel
Help ...

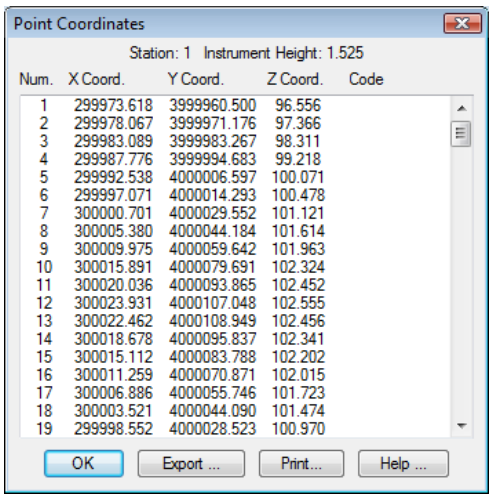
We can check that all the stations have been oriented. Press the **Instrument Setups** button and a dialogue box appears showing the apparatus heights and the horizontal corrections for each one. Click **OK**.



Selecting other stations, the calculated coordinates appear as before. Choose station 8 in **Origin Station** list. We can see that the calculated coordinates appear from 2, 5, 10 and 11. Further on we will see other methods to help us better understand this concept. If we wish to check the station coordinates, we press the **Coordinates** button in the **Stations** frame.

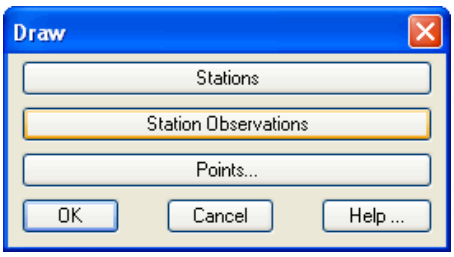


The points also have assigned coordinates. To view them press the **Coordinates** button in the **Points** frame.

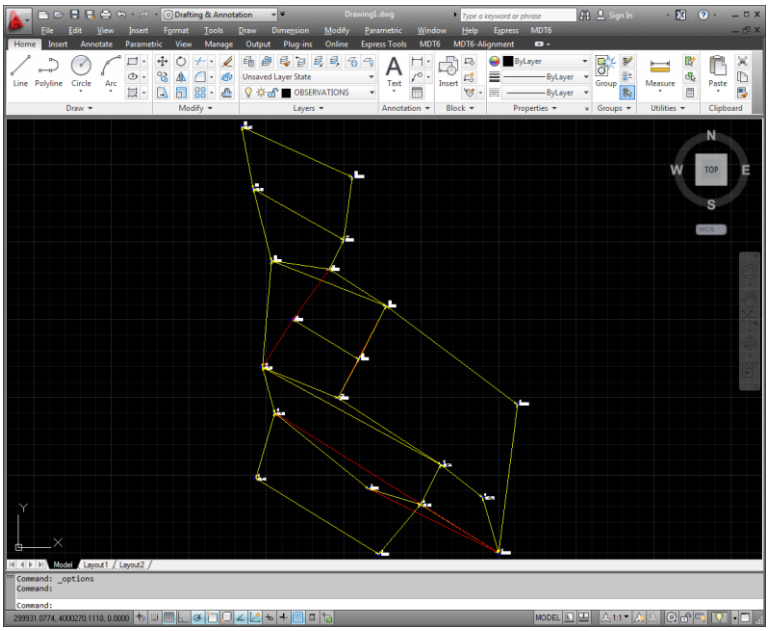


Station and Point Drawing

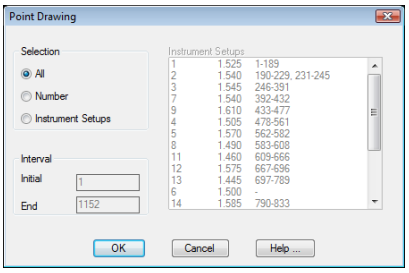
Now we can draw the stations and the points. For stations, in the Station Calculation dialogue box, press the **Draw** button, then **Stations** and then **Station Observations**. Lastly, press **OK** twice and perform a zoom extension.



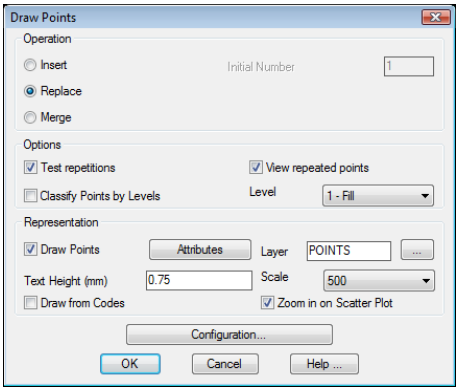
We can see the drawing structure. A triangle, and the mobile stations by a circle represent the fixed stations. A yellow line represents double observations and simple observations are shown in red.



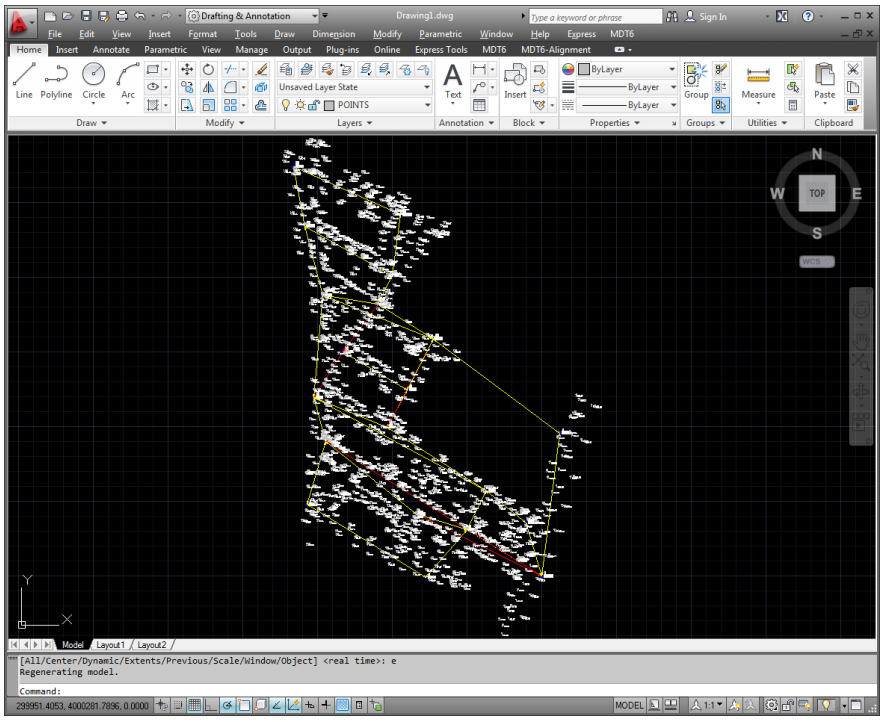
In order to draw the points, we enter again into Station Calculation , but this time choose the **Surveying and Geodesy > Survey > Drawing > Draw Points** command, with the ***All*** option on and press ***OK***.



The next dialogue box controls the drawing parameters. We use a scale of **1:500** and leave the rest of the values unaltered. Click ***OK***.



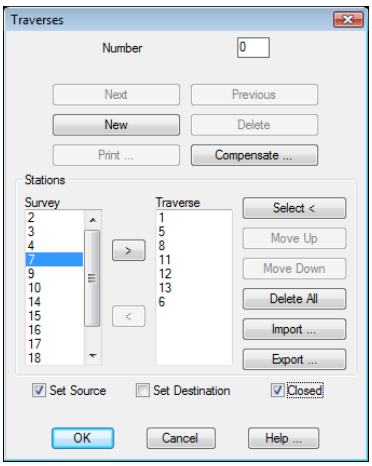
We can now join the point in DTM to create the drawing.



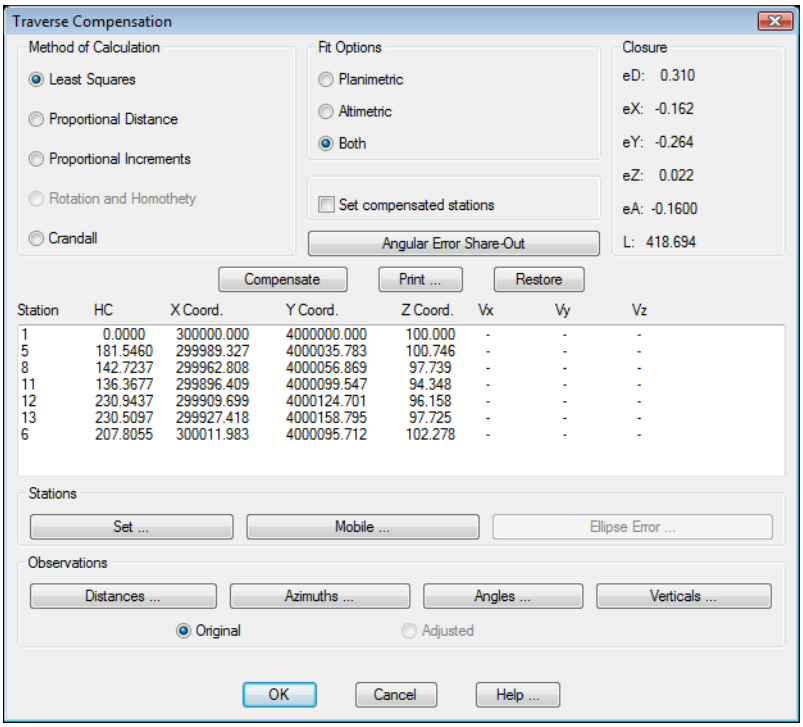
Traverses

We now have a set of provisional coordinates for each station. We now compensate them with the calculation of a traverse. In this case it would be advisable to use a net to calculate for the whole job, but it is also possible to calculate by zones. We hide the point first using the **Utilities > Vision** command, deactivating the **Points** box.

Enter into **Surveying and Geodesy > Surveys > Traverses**. In the **Survey** stations list, double click on stations 1,5,8,11,12, 13 and 6, in that order, so that traverse list is populated. Observe that the **Fix Origin** box has automatically been activated. Also activate the **Closed** box and press the **Compensate** button.

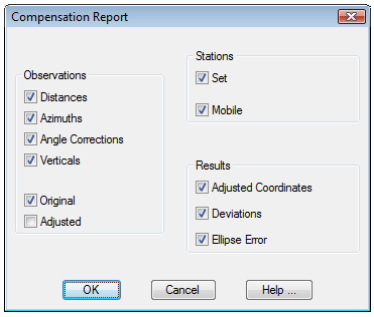


A new dialogue box appears showing the provisional station coordinates and the closing error in X,Y,Z and angle.

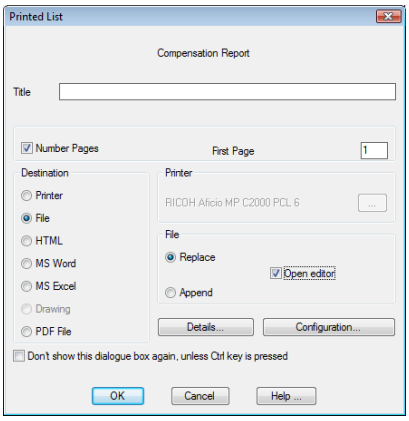


Check that the **Calculation Method** is set to **Least Squares** and press the **Compensate** button. Check that the coordinates for all the mobile stations have been changed and that the applied displacement is shown.

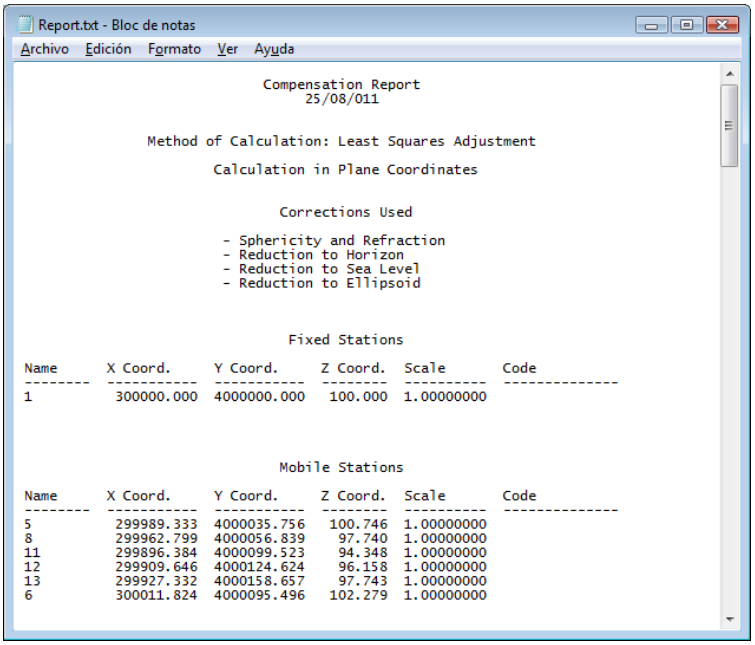
Now press the **Print** button, leaving the default values as they are and then press **OK**.



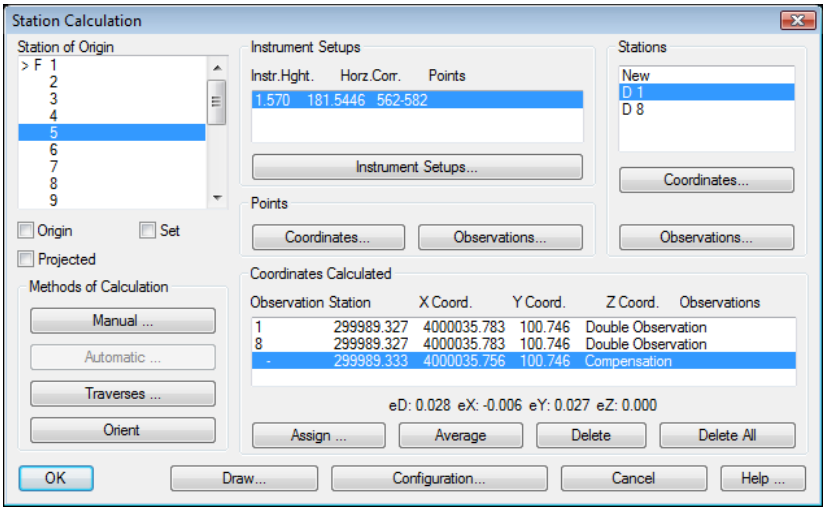
Select **File** in the following dialogue box, showing the list destination, and activate the **Open Editor** box. Press **OK** and choose the `report.txt` file as the file name.



The notepad will now open showing the compensation report for the specified sections.


Report.txt - Bloc de notas
Archivo Edición Formato Ver Ayuda
Compensation Report
25/08/011
Method of Calculation: Least Squares Adjustment
Calculation in Plane Coordinates
Corrections Used
- Sphericity and Refraction
- Reduction to Horizon
- Reduction to Sea Level
- Reduction to Ellipsoid
Fixed Stations
Name X Coord. Y Coord. Z Coord. Scale Code
1 300000.000 4000000.000 100.000 1.00000000
Mobile Stations
Name X Coord. Y Coord. Z Coord. Scale Code
5 299989.333 4000035.756 100.746 1.00000000
8 299962.799 4000056.839 97.740 1.00000000
11 299896.384 4000099.523 94.348 1.00000000
12 299909.646 4000124.624 96.158 1.00000000
13 299927.332 4000158.657 97.743 1.00000000
6 300011.824 4000095.496 102.279 1.00000000

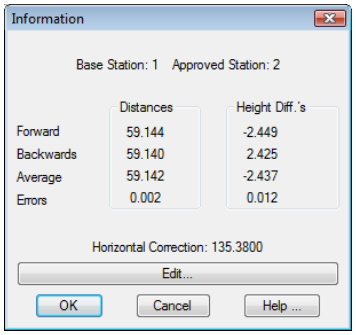
Close the notepad and accept the open compensation dialogue boxes. Choose the **Surveying and Geodesy > Surveys > Station Calculation** command again. Select one of the stations in the calculation, such as number **5**. Check, as well as the previous coordinates that the ones produced by the calculation are also shown. Maximum errors in coordinates and distance should also been shown.



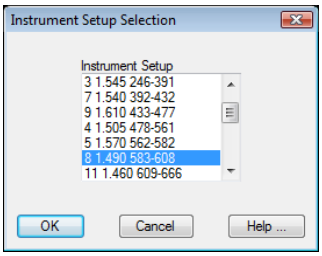
Other Calculation Procedures

The Surveying module also allows the survey calculation to be performed with more control. We will manually calculate two stations. Select station **1** in **Origin Stations** list and station **2** in the **Target Stations** list. Press the **Manual**

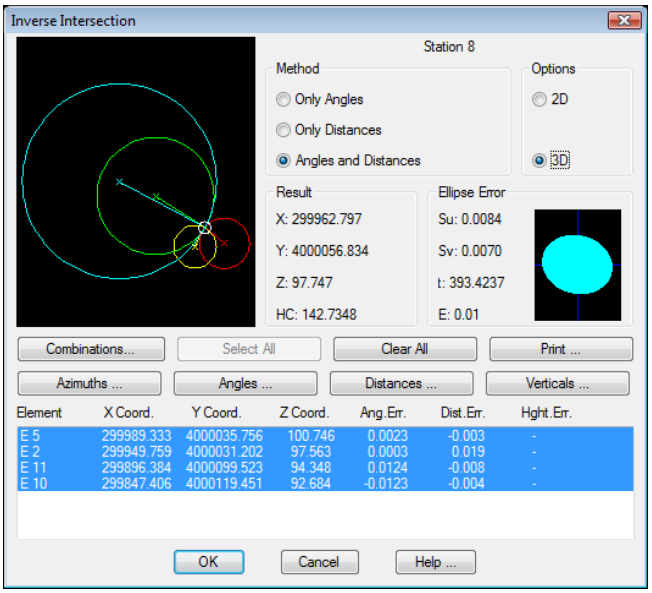
button. The program show the information from the observations of 1 to 2 and from 2 to 1, as well as the distances and slopes both coming and going, with their associated disorientation.



Now choose the **Surveying and Geodesy > Surveys > Utilities > Reverse Intersection** command. Select instrument setup according to station **8** and press ***OK***.



Choose the **Angles and Distances** method and in **Options** highlight **3D**. Observe the representation of angles with respect to the desired station, error ellipse and station 8 station coordinates. Press **OK**.



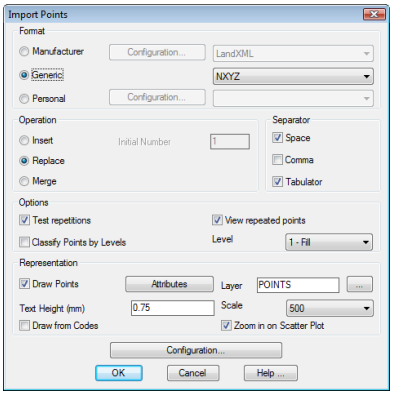
Using again the **Station Calculation** command and selecting 8 as the station of origin, we can see how the new solution for the existing coordinates is presented.

Tutorial 10. Geodesic Calculations

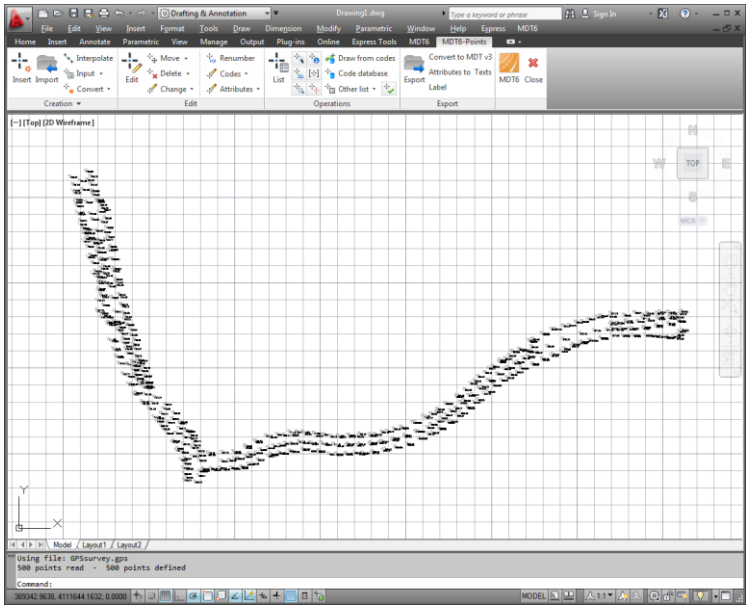
The goal of this example is to import a point file in ED50 / UTM 30 coordinate system gathered in field with TcpGPS software and perform a coordinate transformation to get the points in UTM 30 / ETRS89 projection.

Import Points

Run command **Points > Import** (or in ribbon **Points > Creation > Import**). Set the scale to **500**, press **OK** and select file `GPSsurvey.pun` in folder `C:\MDT6 projects\Tutorial10`.



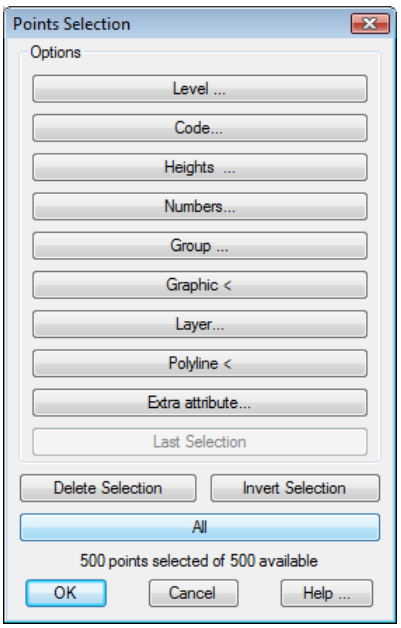
The points drawing will be shown:



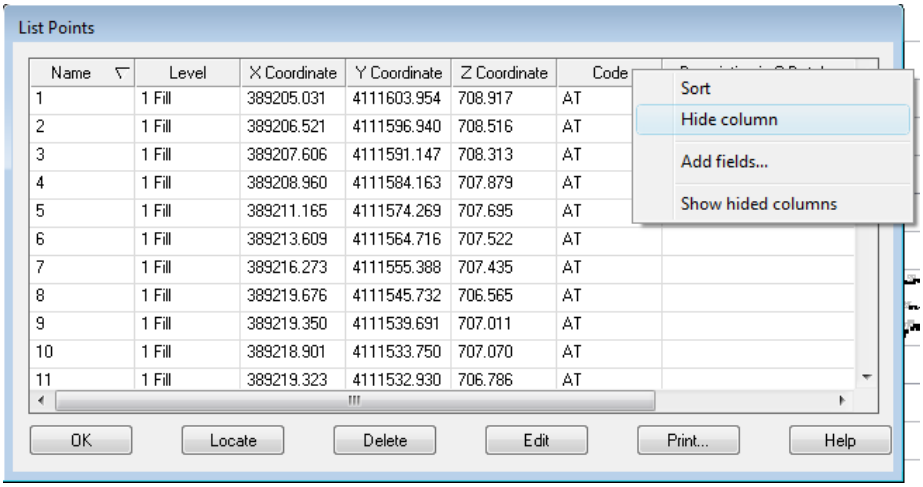
GPS Data Visualization

The points file has an associated file with the same name and extension `*.GPS` containing information from the raw data received at the time when the recording was made at each point. These data include, among others, the WGS-84geographical coordinates, number of satellites, horizontal and vertical accuracy, the PDOP and height of pole.

Run command **Points > List Points** (or in ribbon **Points > Operations > List**) and press **OK** in points selection window. All available points will be shown in the dialog.

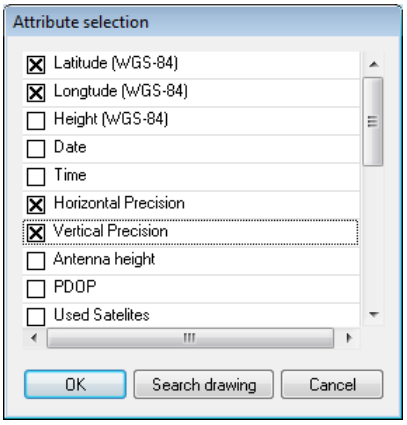


By default, only will be shown the fields of points file.

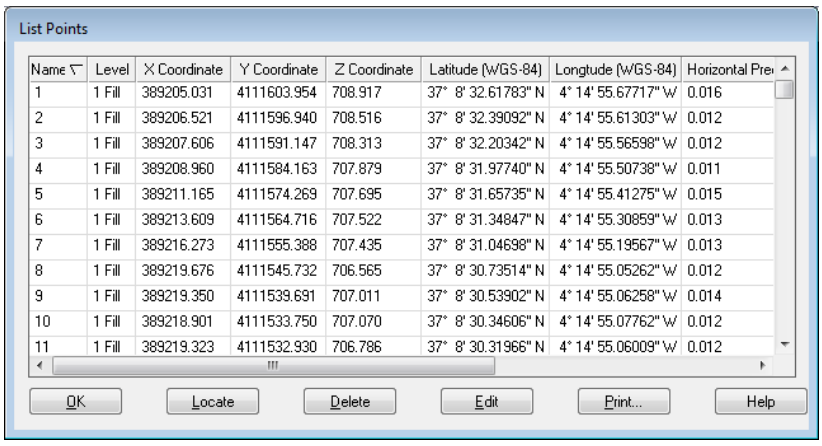


Press the right mouse button on the **Code** column heading and select **Hide Column** option. Do the same for the Description column in BDC.

To add the GPS information associated with each point, press the right mouse button on the title row, choose **Add Fields** option and mark the fields shown below:



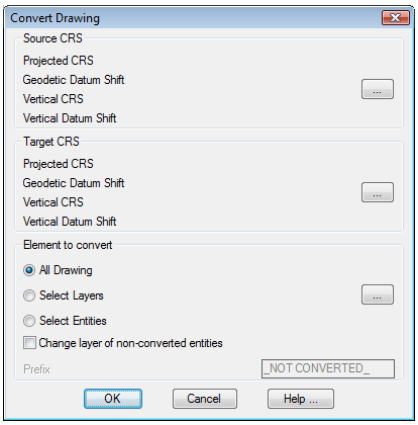
Press **OK** to visualize the listing of points with additional information selected.



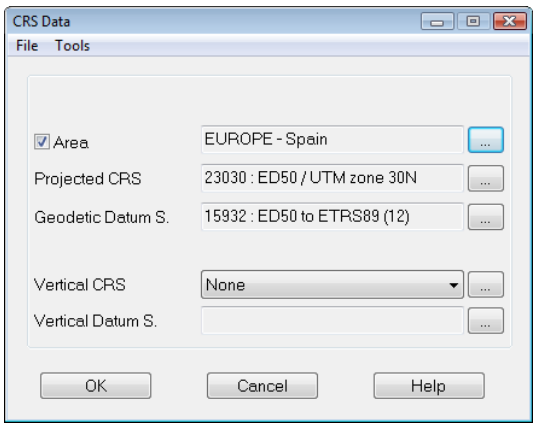
Drawing Coordinate System Transformation

As explained initially, the points have been taken with ED50 / UTM 30 coordinate system. Now we will convert the geographic coordinates sent by the GPS to ETRS89 using a grid file with NTv2 format supplied by spanish National Geographic Institute.

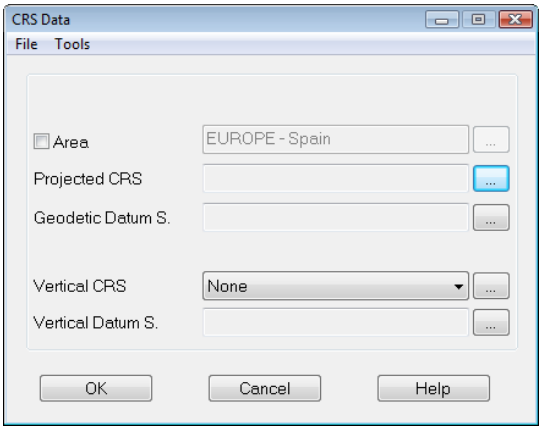
Run command **Surveying and Geodesy > Convert Drawing**.



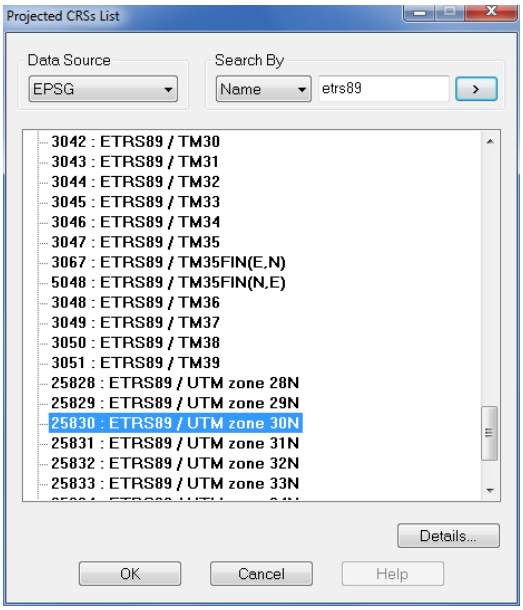
Press the button **…** in the Source Coordinate Reference System (CRS) frame. Enter code **23030** for **Projected CRS** and **15932** for **Geodetic Datum Shift** as shown in the figure and press **OK**. This is the coordinate system used to get the survey data.



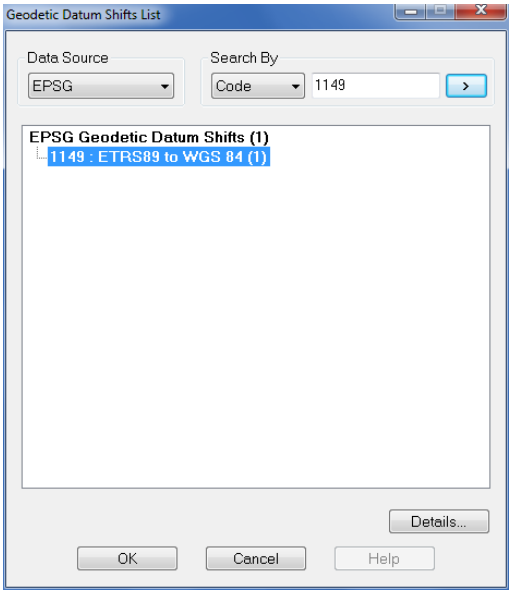
For destination system, press button **…** in **Target CRS** frame.



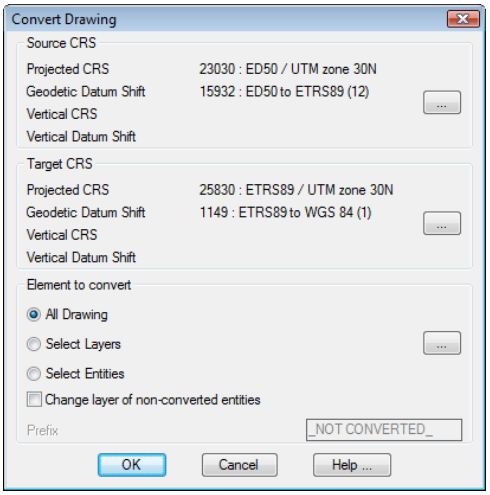
Uncheck **Area** toggle and press **…** button for **Projected CRS**. In **Search By** select **Name**, enter **etrs89** and press **>** to search. Select projection with code **25830**, corresponding to **UTM zone 30N**.


Projected CRSs List
Data Source
EPSG
Search By
Name
etrs89
3042 : ETRS89 / TM30
3043 : ETRS89 / TM31
3044 : ETRS89 / TM32
3045 : ETRS89 / TM33
3046 : ETRS89 / TM34
3047 : ETRS89 / TM35
3067 : ETRS89 / TM35FIN(E,N)
5048 : ETRS89 / TM35FIN(N,E)
3048 : ETRS89 / TM36
3049 : ETRS89 / TM37
3050 : ETRS89 / TM38
3051 : ETRS89 / TM39
25828 : ETRS89 / UTM zone 28N
25829 : ETRS89 / UTM zone 29N
25830 : ETRS89 / UTM zone 30N
25831 : ETRS89 / UTM zone 31N
25832 : ETRS89 / UTM zone 32N
25833 : ETRS89 / UTM zone 33N
Details...
OK
Cancel
Help

For Datum Transformation, press **…** for **Geodetic Datum S**. In **Search By** select **Code** option, enter **1149** and press **>**. Select **ETRS89 to WGS 84 (1)** and press **OK**.



The dialog for conversion of drawing should appear as follows:



Press **OK** to convert the drawing, and then zoom extension. Check how all the coordinates has changed.